CARDIOMD

SERVICE MANUAL

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INTRODUCTION

This Service Manual for the CardioMD Dual Detector camera provides a detailed description of the camera, enabling trained service personnel to install, update, trouble-shoot and repair the CardioMD system.

This manual describes Series III CardioMD systems (the most recent version of the system), as well as earlier systems (Series I and II). If in doubt, check the serial number label on the rear of the system's gantry to see the version of the system.

I, II Information that applies only to CardioMD Series I and II systems is marked with this symbol.

III Information that applies only to CardioMD Series III systems is marked with this symbol.

The manual comprises the following sections:

Chapter 1 covers safety concerns that must be taken into consideration when operating the CardioMD system.

Chapter 2 gives a short overview of the CardioMD system.

Chapter 3 gives a more detailed description of the different components comprising CardioMD.

Chapter 4 details how to calibrate both the motion axes and the CardioMD detectors.

Chapter 5 gives guidance to diagnosing CardioMD in case of faults.

Chapter 6 specifies repair procedures.

Chapter 7 gives guidance on software firmware updating and programming.

Chapter 8 includes information for installing CardioMD at customer sites.

Chapter 9 holds a list of field replaceable units.

Chapter 10 details how to measure NEMA performance on the CardioMD system.

Chapter 11 specifies requirements for planned maintenance on CardioMD.

Chapter 12 describes the CardioMD AC Option in detail and provides instructions for installation, repairs and updates of the AC Option.

1 SAFETY

Contents

1.1 Safety Concerns

This chapter contains important information concerning potential hazards and general safety precautions. The meaning of the safety instructions is to draw attention to potential hazards that will or may occur if instructions are ignored. These hazards may lead to accidents or serious injury to the patient, operator or service personal.

2.1 Introduction

The CardioMD System incorporates many safety features to protect the patient and the operator. However, as with all medical devices of this nature, safe use of the system relies on the knowledge and judgment of medical professionals.

3.1 Safe Operating Practices

1.3.1 Operator Safety

Do not attempt to operate the system until you fully understand the safety considerations and procedures presented in this manual.

To avoid the possibility of getting pinched, keep hands and arms clear of the detector head during positioning and operation.

1.3.2 Equipment Safety

Do not attempt to operate the system if any of the Emergency Stop buttons described in this manual are not functioning properly.

High voltage and mechanical hazards may be encountered when covers are removed.

Always inspect the system for hazardous conditions or equipment malfunction prior to operation. Watch out for abnormal or inconsistent camera control operation, such as intermittent pushbutton operation or interlock switch failure.

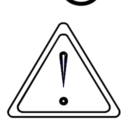
Always make sure that collimators are installed securely.

Confirm that the movement paths of the detectors are clear before performing SPECT acquisitions, manually moving the detectors or initiating preprogrammed setups.

1.3.3 IEC Symbols Used

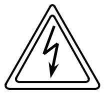
The following symbols are used on the system and in this manual:

Alternating current

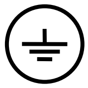


WARNING. Indicates where not following the procedure exactly as described may be dangerous and possibly cause bodily injury or death. Please consult accompanying documents for detailed instructions before proceeding.

RADIATION. Indicates where not following the procedure exactly as described may lead to exposure to radiation and possibly cause bodily injury or death. Please consult accompanying documents for detailed instructions before proceeding

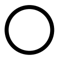


Denotes a hazardous voltage. Indicates where not following the procedure exactly as described may be dangerous and possibly cause bodily injury or death.



Denotes protective earth point.

ON / Power.



OFF / Power.

Type B equipment.

1.3.4 Definitions

The safety instructions in this manual are intended for the protection of the patient, operator and service personnel. They identify hazards that will or may occur if instructions are ignored and are used as follows:

WARNING

Identifies conditions and actions for which a specific hazard is known to exist which may cause severe personal injury or substantial property damage if the instructions are ignored.

CAUTION

Caution. Identifies conditions or actions for which a potential hazard may exist which will or can cause minor personal injury or property damage if the instructions are ignored.

Note. A note is used to inform the user of operator information which is important but not hazard-related.

III

This symbol indicates information and instructions applying to CardioMD Series III systems.

I, II

This symbol indicates information and instructions applying to earlier versions of the CardioMD system.

1.3.5 Restrictions On Use

CAUTION

Caution. This equipment is intended for use by trained qualified personnel only.

CAUTION

Caution. Using controls or adjustments or performing procedures other than those specified in this manual may result in severe personal injury or equipment damage.

1.3.6 Hazards

Electrical Hazards

WARNING

- The CardioMD system is provided with covers to protect the patient and operator from electrical shock and mechanical hazards. Make sure that all covers are properly mounted when returning the system to the customer.
- Only power the acquisition computer from the power supply located in the gantry base.
- Do not use any other type of mains cable or interconnecting power cables than those shipped with the system.

Mechanical Hazards

WARNING

- Equipment motion can cause severe injury and equipment damage.

Precautions

To avoid injury or equipment damage:

- Carefully observe all equipment motion as you operate the controls. Uncontrolled or unmonitored movements can cause the gantry, table or detectors to collide with personnel or other equipment.
- Check for obstructions before initiating any hand controlled motions such as moving the detectors. Be careful not to drive the detectors into fixed objects.
- Make sure that no body parts are at risk to become pinched or trapped when the equipment is moving.
- Do not lean anything against the equipment. Doing so could cause it to tip or fall and may result in injury or equipment damage.

WARNING

Do not attempt to operate the gantry without collimators secured to the detectors.

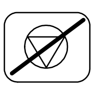
1.3.7 Emergency Stop

Pressing the Emergency Stop button located on the side of the gantry or the one located next to the acquisition PC will stop and disable all motion.

Figure 1.1 Emergency Stop buttons
Note. The appearance of your system may be slightly different from the systems shown in the photographs of this manual. However, there is no difference in functionality

Note. E-stop buttons latch mechanically when pressed. To release an E-stop button, turn the button in the clockwise direction.

Pressing an Emergency Stop button causes the current acquisition to stop. Any acquisition motion, for example tomography, will cease.



When the Emergency Stop button is released (and power to the rest of the system has not been interrupted), you can enable hand controlled motion by pressing the hand controller Collision Override Button once. An interrupted acquisition remains stopped until you instruct the system to resume or restart the acquisition.

2 SYSTEM OVERVIEW

Contents

2.1 Introduction

CardioMD is a nuclear medicine gamma camera system intended for cardiac imaging. A dedicated acquisition PC executes all acquisition protocols.

Acquisition data from the PC can be sent via DICOM to a workstation for further processing.

For use with the CardioMD system, Philips Medical Systems offer a choice of two processing stations:

- The Pegasys Ultra™ workstation
- The JET*Stream*® Workspace Cardiology Module.

For further information on these, please refer to the relevant workstation documentation

DICOM (Digital Imaging and Communications in Medicine) is a NEMA standard that defines a means of exchanging image files and other information between DICOM compliant devices. DICOM provides image network file transfer capabilities between the CardioMD acquisition PC and the workstation.

Note. DICOM data transfer between the CardioMD and any workstation other than those specified above is not a valid configuration and is not supported.

2.2 System Components

The system architecture is illustrated in the schematic block diagram below.

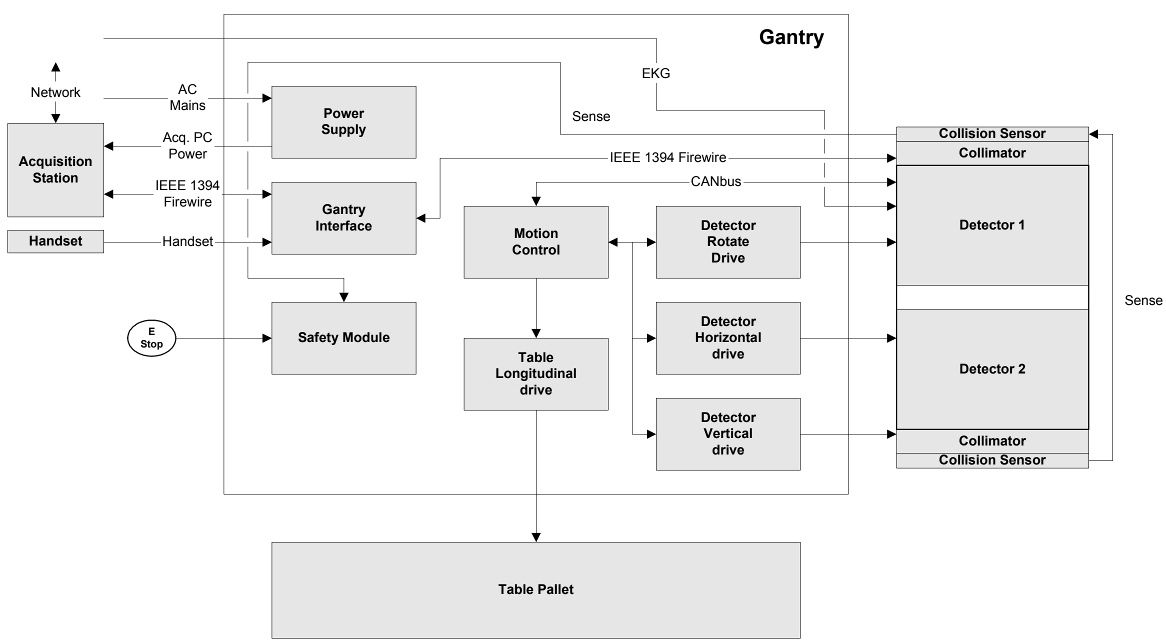


Figure 2.1 CardioMD system components

2.2.1 Gantry

The gantry forms the basis of the CardioMD gamma camera. All external devices are connected to the gantry from where the signals are distributed to the various system components. The gantry contains most of the system's electronics, such as power supplies, motors and motion controllers.

The main gantry structure consists of a steel structure with a moveable base onto which a pillar with the detectors is mounted. Next to the pillar base, the patient table is mounted onto a second steel construction, the table console, which houses the majority of the CardioMD electronics.

2.2.1.1 Motions

The gantry can perform motorized motions driving the detectors horizontally towards and away from the patient table. The drive performing these motions is referred to as the X drive and is located in the gantry base behind the pillar holding the detectors. The X motion is controlled by the connected acquisition PC or the hand controller.

A second drive, the Y drive, is located in the top of the pillar. This drive is used to move the detectors up and down as controlled from the acquisition PC or hand controller.

The rotate drive is located in the arm connecting the detectors to the pillar. This drive is used to rotate the detector assembly, under the control of the acquisition PC or hand controller.

The patient table can be moved horizontally along its longitudinal axis. This motion is effected by the table drive located underneath the table pallet. The table longitudinal motion is used for patient positioning and is controlled from the hand controller.

2.2.1.2 Covers

The covers of Series III CardioMD systems are slightly different from those of earlier systems, as shown in Figure 2.2 and Figure 2.3.

The steel gantry construction has four main covers. Removal of these gives access to all gantry electronics and drives.

- At the rear of the base behind the Y axis pillar (‘the tower’), a cover protects the X drive.
- The tower has a top cover and a side cover protecting the Y drive.
- The console supporting the patient table has a front and a rear cover. Removal of these covers gives access to the gantry electronics. The table drive is located behind the rear cover.
- The detector arm with the rotate drive has a top and a bottom cover.

III

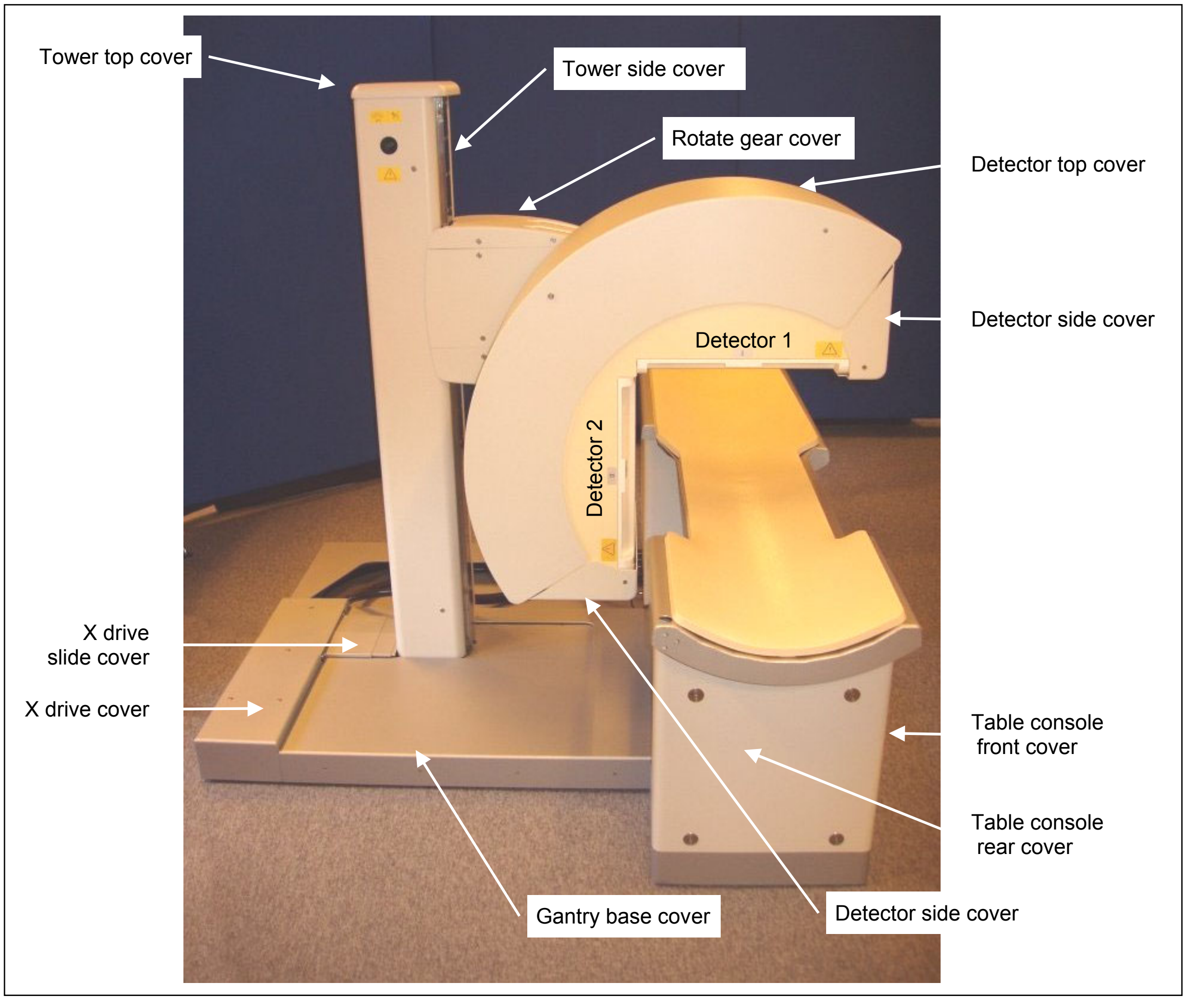


Figure 2.2 CardioMD Series III covers

I, II

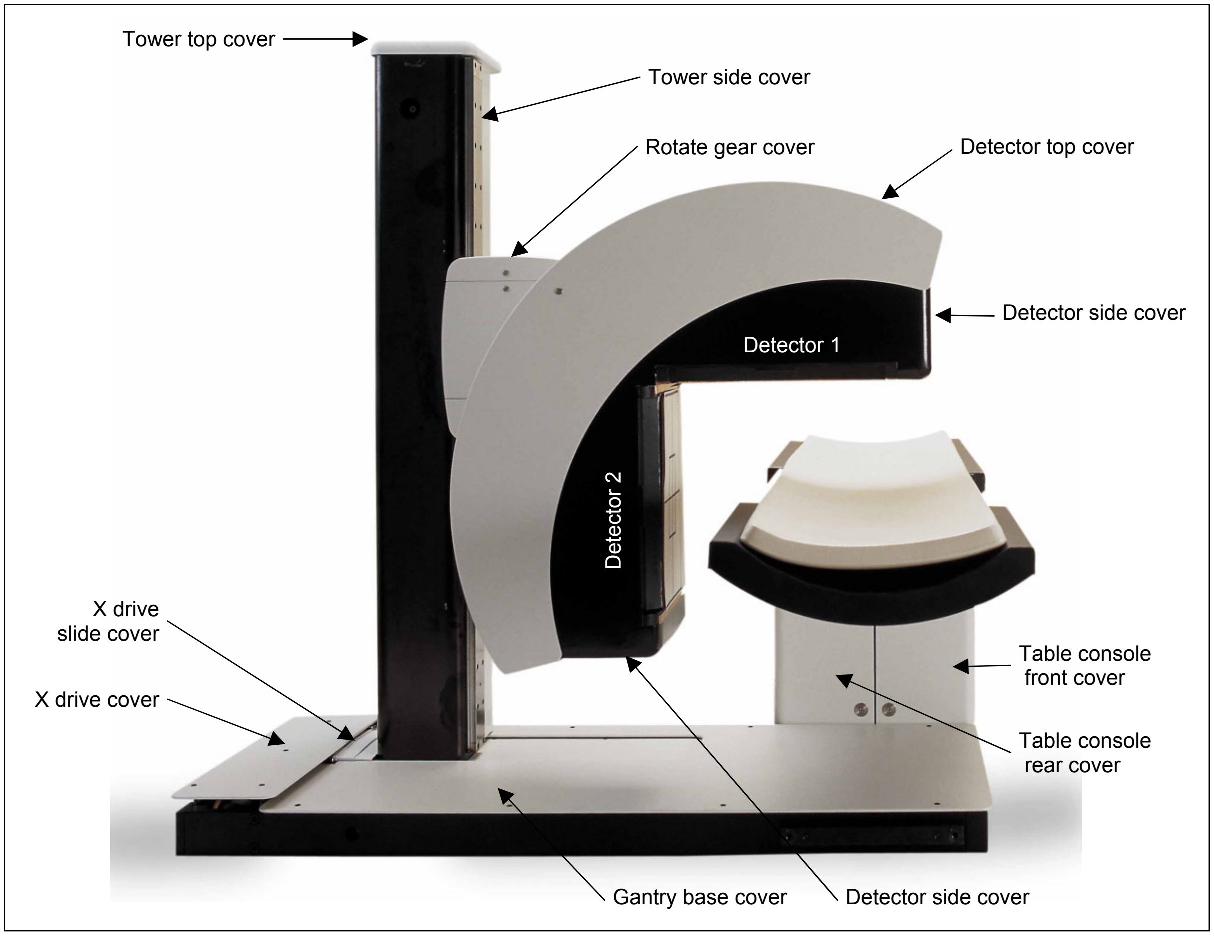


Figure 2.3 CardioMD covers – series I and II systems

2.2.1.3 Patient Table

The table console supports the patient table pallet. The table pallet is supported at the other end by a roller system allowing for longitudinal movement of the pallet.

The pallet is made of a 3 mm aluminum plate and will attenuate approximately 10 % of the counts at 140 keV. The pallet comes in two versions:

- In one configuration, the length of the table pallet length is 280 cm. This configuration supports both prone and supine imaging.
- For small room installations, a shortened table (200 cm) for supine imaging only is provided.

The capacity of both table versions is 400 lbs. (180 kg).

The height of the table is fixed. The table can be moved along its longitudinal axis by means of a motor controlled from the CardioMD hand controller. This motion is intended for fine tuning of the patient's position relative to the detectors. There is no manual movement as part of normal operation.

2.2.1.4 Control System

CardioMD can be controlled both from the acquisition PC and from the hand controller.

The acquisition PC interfaces to the gantry via a standard IEEE 1394 FireWire control interface. The FireWire interface is used for all communication between the CardioMD gantry and the acquisition PC, including the transmission of acquisition data to the PC.

For all detector motions, relative position feedback is provided by an incremental encoder (relative encoder). On the rotate and vertical detector axes, the incremental encoder is implemented by a resolver that is an integral part of the motor. The resolver output is converted to an incremental signal by the motor amplifier. On the horizontal detector axis, an incremental encoder is mounted on the motor shaft (as an integral part of the motor).

For absolute position information, the rotate, X and Y axes have absolute encoders. The absolute encoders are used for position calibration after gantry power-up to index the relative encoders to a known position. After this, the motion controllers simply look at the relative encoders for position feedback but compare their outputs to the absolute encoders for verification. As long as the two encoders for each motion (excluding the table) are in agreement as to the position, the motion controllers are “happy”. If the positions deviate too much, all motions are halted (motor power is removed).

The table axis has a simple position indicator switch which changes state when the mid-position is reached. This is used to place the table at center position when the system moves to the patient load position.

Motions are controlled by two dual-axis motion controllers (CANbus controllers) coupled in a master-slave arrangement using a high speed synchronous communication link between the two.

The acquisition PC communicates only with the master controller. When the master controller receives a motion command, it calculates the trajectory of the detectors and the instantaneous velocity for each of the three axes (rotate, X, and Y). It controls the rotate axis directly and transmits X and Y motion commands to the slave controller, which controls the X and Y detector movements.

2.2.1.5 Power Supply

Power to the entire system is applied to the AC mains input on the gantry. The CardioMD has a maximum power consumption of 1800 VA (including the power consumption of the acquisition PC), which allows the CardioMD to be powered from a standard AC mains supply outlet.

Note. Because the acquisition PC is powered from the gantry, the PC should be shut down properly before gantry power is removed.

2.2.1.6 Emergency Stop Buttons

The CardioMD system has two Emergency Stop buttons, one located on the side of the table console and one located next to the acquisition PC. The purpose of the E-Stop buttons is to stop and disable all motions. Pressing the E-Stop causes motions to cease.

When the Emergency Stop button is released (and power to the rest of the system has not been interrupted), the hand controlled motion is enabled but an interrupted SPECT acquisition will remain stopped until restarted or resumed by the operator. The Emergency Stop button is released by rotating the button clockwise.

2.2.1.7 Collision Sensing System

The CardioMD system is provided with collision sensors:

- On the collimators

- On the detector surfaces facing the patient
- On the detector side and top covers
- On the AC Option, if installed (see Chapter 12 *CardioMD AC Option* for details).

The purpose is to detect collisions and stop motions, thereby preventing injury to the patient and operator and damage to the equipment. When a collision sensor is activated, the detectors can only be moved at slow speed by pressing the hand controller Collision Override button *and* a motion button simultaneously.

2.2.2 Detectors

The detector assembly consists of a thallium activated sodium iodide crystal, a glass light pipe, and an array of photomultiplier tubes (PMT's). Gamma photons striking the crystal generate scintillation light with an intensity proportional to the energy loss of the gamma photons. The energy range of gamma photons accepted is from 60 keV to 170 keV. The scintillation light falling on neighboring PMT's also generates pulses proportional to their particular intensities. All PMT pulses are routed to the detector EDC board (located on top of the detector) via coaxial cables.

Note. The crystal has a thin aluminum cover which is biased with negative high voltage.

On the CardioMD detector heads, a PMT produces an analog current relative to the light input. This current is converted into a proportional voltage signal inside each PMT assembly. Voltage signals from all PMT's are combined in groups. The signal from each group is summed to four position signals, X+, X–, Y+, Y–, and an energy signal. These five sum signals are then digitized on the Event Digitization & Control (EDC) board. The digitized signals are integrated and corrected on the fly, followed by X-Y position calculation and energy calculation. Note that the EDC board only processes one event at a time, but fast enough to ensure that no information is lost at count rates experienced in clinical use. Finally, each event is corrected for detector/system characteristics such as spatial linearity and local energy response.

The output from the detector, that is, the corrected event position and energy information, is sent via the FireWire control interface to the acquisition PC for imaging.

The detector assembly is shielded with lead-bronze alloy. This arrangement prevents external light from reaching the PMT's and charged particles from reaching the crystal. It also protects the crystal from most of the gamma photons arriving from the side or rear of the detector. Gamma photons are focused on the crystal by a collimator placed over the detector face. A collimator is a honeycomb structure of lead alloy. The holes in the collimator serve to select the angle in which gamma photons may enter. In each case, the passage of gamma photons forming a projection image is favored, since they are not absorbed by the lead septa between the holes.

The detector automatically identifies the collimator type attached. The collimator type information is transmitted to the acquisition computer for applying appropriate corrections.

2.2.3 Collimator

The CardioMD is designed to support LEGP and LEHR collimators.

The collimator/detector interface allows automatic detection of the collimator type attached, ensuring that appropriate correction is applied.

CardioMD collimators are changed by hand. When not in use, collimators can be stored in the CardioMD collimator cabinet. The CardioMD's motion control system automatically brings the detectors into exchange position when activated by the connected acquisition PC.

2.2.4 Hand Controller

The hand controller is used to position the gantry, table and detector. Furthermore, the hand controller has buttons allowing you to start and stop an acquisition and to set up variable radius tomography motion. A Collision Override button is also provided on the hand controller.

2.2.5 Acquisition PC

The acquisition PC is connected to CardioMD via the FireWire control interface. The acquisition PC uses this interface to control detector motions and to receive corrected events from the detector.

The gantry offers an isolated 115 V AC mains utility (max. 4 A) used for powering the acquisition PC.

III On Series III systems, the power cable to the acquisition PC is routed internally. Furthermore, an ECG gate can be powered from the connector panel on the rear of the table console.

I, II On Series I and II systems, the acquisition PC is powered from the connector panel on the side of the table console.

Note. The acquisition PC must not be powered from any other source than the gantry power supply. The reason for this is that the PC is considered a patient contact device, and electrical problems stemming from an alternate power source may place either the patient's and/or the operator's safety at risk.

3 DETAILED DESCRIPTION

Contents

3.1 Introduction

This section provides detailed information on the functionality of the CardioMD system.

3.2 Gantry

The CardioMD Gantry is based on a pillar design supporting the detectors. The gantry pillar has a rotation gear on which the detectors are mounted. The pillar features vertical detector movement. Together with a horizontal movement of the entire pillar and the ability to rotate the detector, circular and non-circular orbits around a patient can be achieved.

Figure 3.1 gives an overview of the CardioMD gantry for Series III systems, Figure 3.2 illustrates the same for Series I and II systems.

III

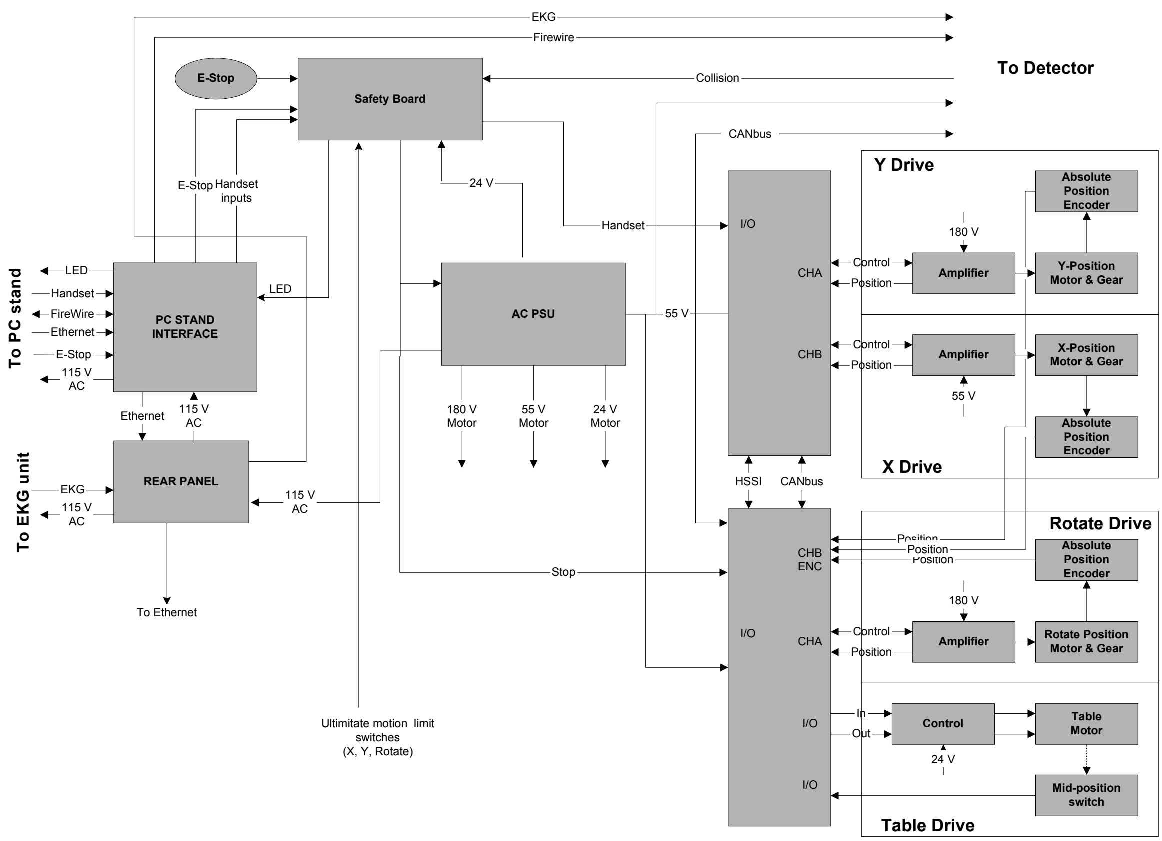


Figure 3.1 Gantry schematic block diagram, CardioMD Series III systems

III

On Series III CardioMD systems, the acquisition PC is connected to the gantry internally (power supply, IEEE 1394 FireWire communication, LAN connection). The hand controller plugs into a panel on the acquisition PC stand. A connector panel on the rear of the table console allows the connection of:

- An ECG gate (power supply output, R-wave input)
- A local area network (RJ45 connector).

I, II

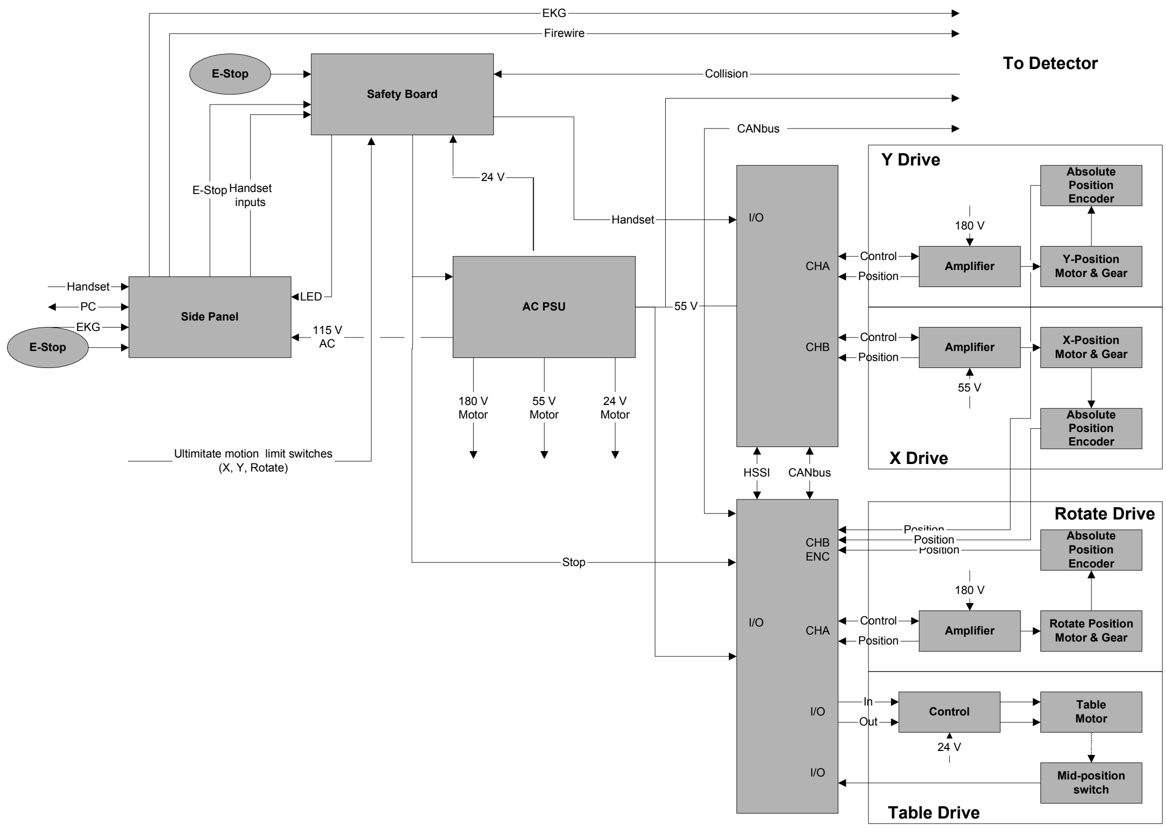


Figure 3.2 Gantry schematic block diagram, CardioMD Series I and II systems

I, II

On Series I and II CardioMD systems, the side panel contains all interface connectors to peripheral devices, including the acquisition PC and the hand controller. A 115 V AC power supply output is available for the acquisition PC, along with IEEE 1394 FireWire communication, which is routed directly to the detectors. An input connector for an ECG trigger is also provided. This R-wave input is also routed directly to the detector EDC modules where the trigger events are encoded into the data stream going to the PC.

Interconnections of Series III and earlier systems are shown in the diagrams Figure 3.3 and Figure 3.4.

III

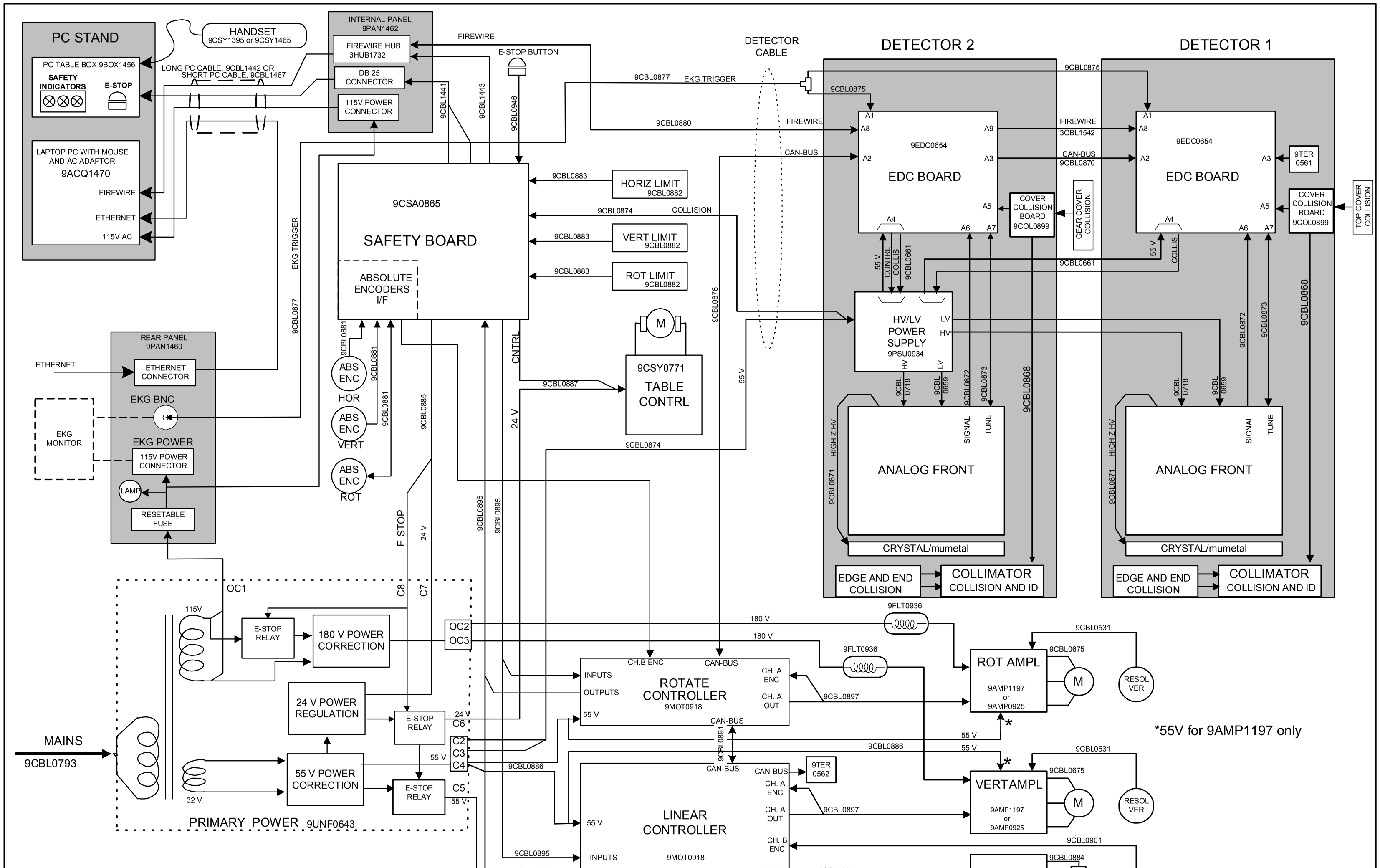


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Figure 3.3 Interconnections CardioMD Series III

I, II

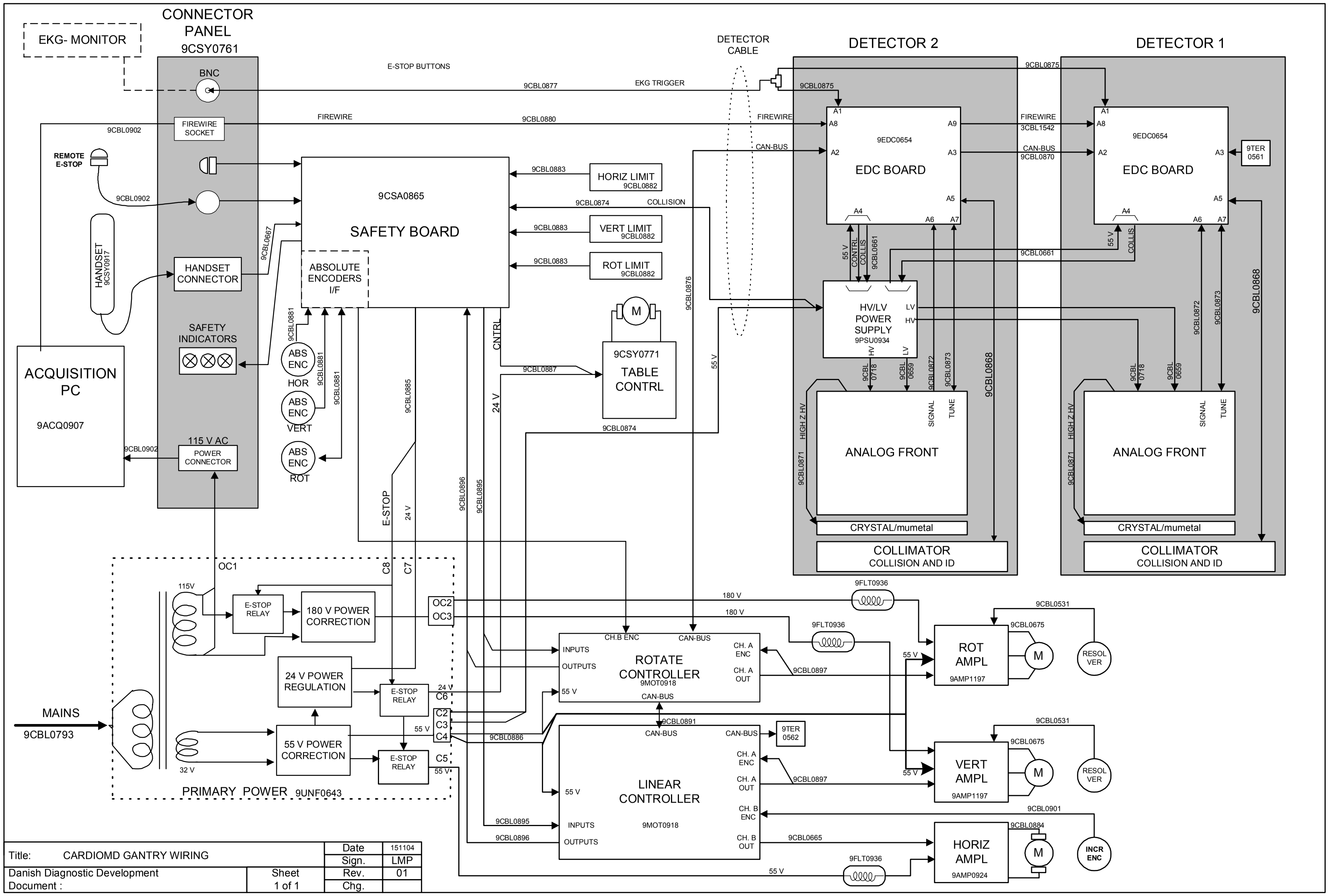


Figure 3.4 Interconnections, CardioMD Series I and II

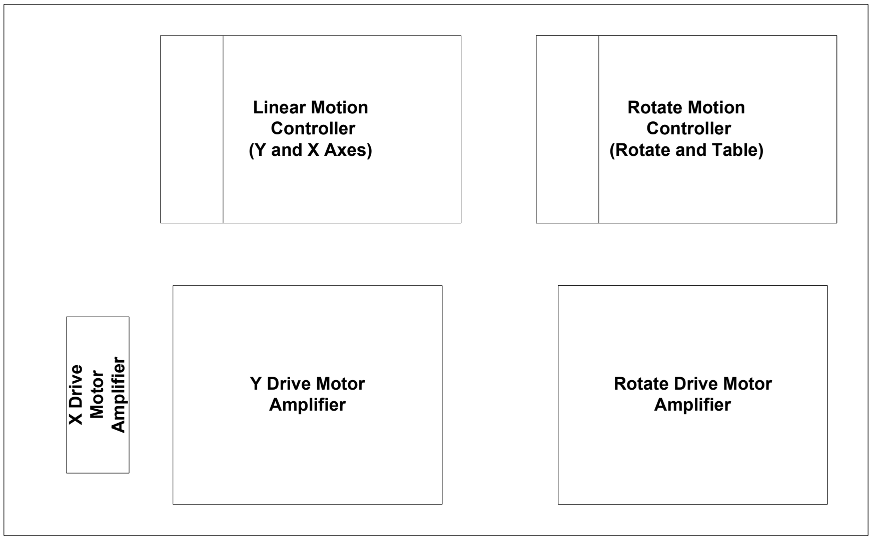


Figure 3.5 Electronics behind front cover

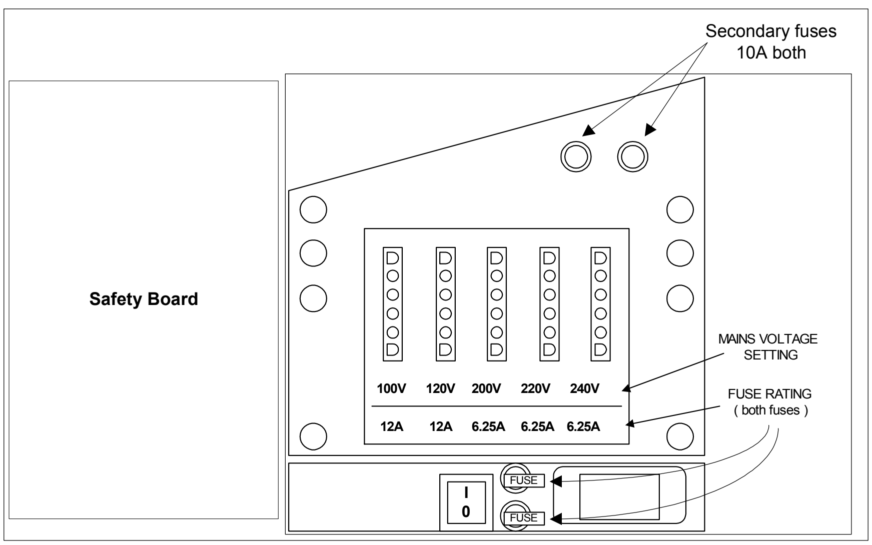


Figure 3.6 Electronics behind rear cover

3.2.1 AC Power Supply

The gantry power supply is located in the lower left corner in the rear of the table console. It powers the entire system except for the processing station. The outputs are divided into two groups:

- One group of continuous outputs (see Table 3.1 on page 3-7)
- One group of safety interrupted outputs (see Table 3.2 on page 3-7).

All low voltage outputs are protected by PTC fuses.

Note. To reset the PTC fuses, all loads on the affected output must be removed; power must be removed momentarily and then reapplied. Any capacitance within the circuitry will cause the fuse not to reset. These fuses are not accessible and are not field-replaceable. Should one of these fuses fail, the entire power supply must be replaced.

III I, II

Connector Name	*Voltage*	*Function*
OC1	115V AC	Series III: ACQUISITION PC and ECG gate Series I and II: ACQUISITION PC
C1	55V DC	SPARE
C2	55V DC	DETECTOR 1 EDC BOARD AND DETECTOR PSU
C3	55V DC	DETECTOR 2 EDC BOARD
C4	55V DC	BOTH MOTION CONTROLLERS ROTATION AND VERTICAL AMPLIFIER*
C7	24V DC	SAFETY BOARD

* if these are of the type that requires 55 V DC input

Table 3.1 Continuous outputs

Connector Name	*Voltage*	*Function*
OC2	180V DC	ROTATE DRIVE AMPLIFIER
OC3	180V DC	Y DRIVE AMPLIFIER
C5	55V DC	X DRIVE AMPLIFIER
C6	24V DC	TABLE DRIVE

Table 3.2 Safety interrupted outputs

Connector C8 goes to the Safety Stop circuit. This input is used to interrupt power to the motors in case of collision, motion controller software fault, or if one of the E-Stop buttons is pressed.

The electronics within CardioMD, including the detectors, are operated on uninterruptible 55 V DC. Local DC-DC converters internal to the electronic modules convert the 55 V DC supply voltage to the voltage levels used internally (i.e., 3.3 V DC, +/– 5 V DC, 12 V DC, +/– 15 V DC and HV).

The AC power supply contains a number of fuses. The access and location of these fuses are indicated in Figure 3.6 on page 3-6. The electrical location of the fuses is shown in Figure 3.7 below.

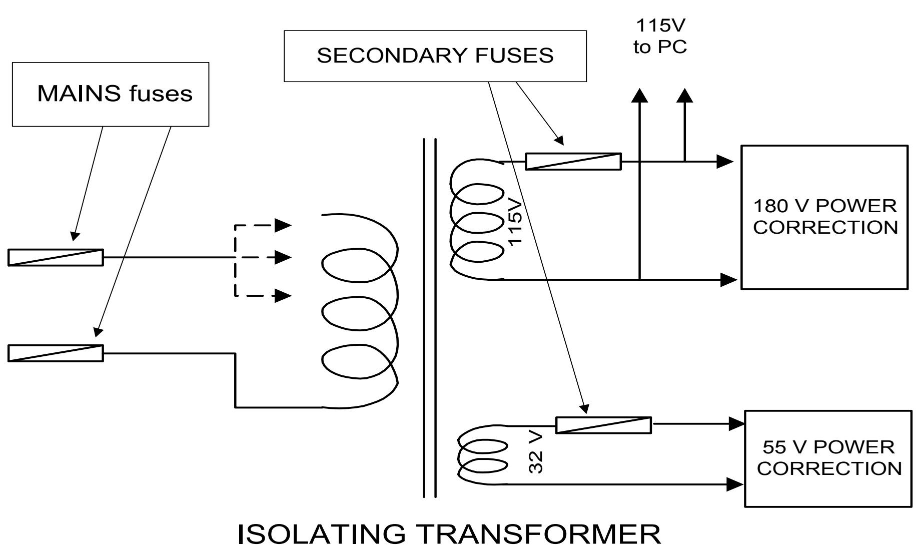


Figure 3.7 Electrical location of fuses in power supply

3.2.2 Safety Board

The safety board is located in the rear of the table console. Its primary function is via on-board relays to cut the motion power when required for safety reasons.

Relays on the board interrupt power to all motions at safety stops (that is, when an E-Stop occurs, when a motion runaway is detected, etc.). These relays send a stop signal to the main power supply and to the motion controllers. The motion controllers issue a message causing the acquisition PC to display a message to the operator.

Furthermore, the safety board acts as a cable distribution point distributing signals.

The hand controller interfaces directly to the safety board. The hand controller Collision Override button and Stop buttons are hardwired to relays in the safety circuit. The other hand controller buttons are passed on to inputs on the linear motion controller.

The safety board includes a number of switches and pushbuttons used to calibrate the three absolute encoders. These are indicated in Figure 3.8 on page 3-9.

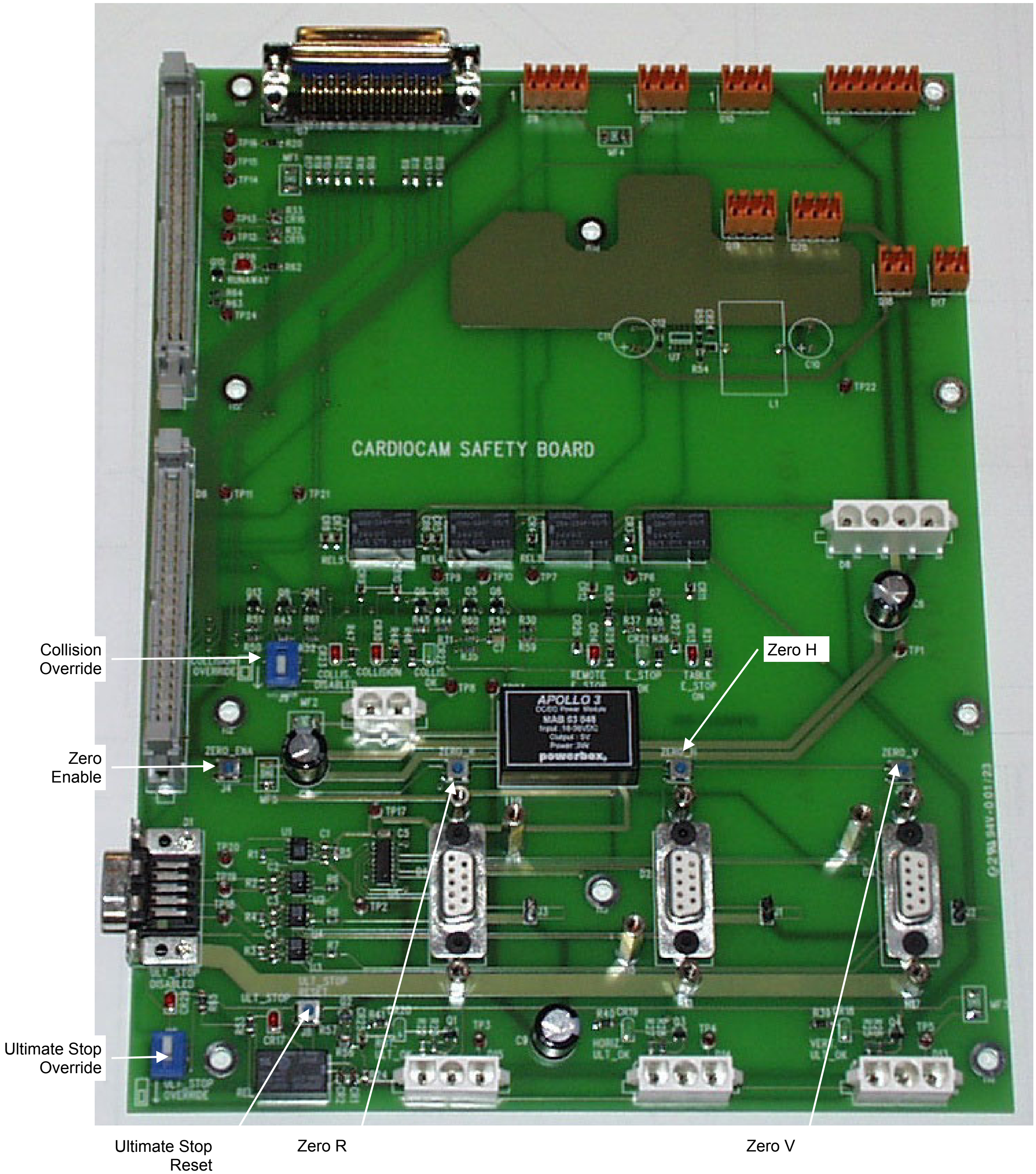


Figure 3.8 Jumpers and switches on the safety board

The function of the switches shown in Figure 3.8 is as follows:

Switch	*Designation*	*Type*	*Description*
Collision Override	COLLISION OVERRIDE	Slide switch	This switch function is for manufacturing and service purposes. When the switch is ON (position downwards), the collision sensing on the collimators and detectors is disabled. At the same time, the adjacent red LED is lit, indicating that a safety function is disabled. **Caution**. Make certain that the switch is OFF (position upwards) when the system is in normal use
Ultimate Stop Override	ULT_STOP OVERRIDE	Slide switch	This switch disables the bi-stable Ultimate Limit relay output. If a motion has passed its ultimate end stop, the Limit relay interrupts power to the system and the Ultimate Stop Override has to be applied in order to re-enable motor power to be able to back out. Use the Collision Override button and the appropriate motion button on the hand controller. An adjacent red LED is lit when the switch is ON. **Caution**. Make certain that the switch is OFF (position upwards) when the system is in normal use
Ultimate Stop reset	ULT_STOP RESET	Push button	This button resets the bi-stable Ultimate Limit relay output. The relay must be reset after clearance of the motion at the ultimate stop limit
Zero Enable	ZERO_ENA	Push button	This button is used to set the calibration points for the absolute encoders for the rotate, horizontal and vertical motion calibration points. The button must be pressed simultaneously with each of the motion specific set buttons (Zero R, Zero H, Zero V)
Zero R	ZERO_R	Push button	This button sets the absolute encoder calibration point for the rotate axis when pressed simultaneously with the Zero Enable button
Zero H	ZERO_H	Push button	This button sets the absolute encoder calibration point for the horizontal (X) axis when pressed simultaneously with the Zero Enable button
Zero V	ZERO_V	Push button	This button sets the absolute encoder calibration point for the vertical (Y) axis when pressed simultaneously with the Zero Enable button

Table 3.3 The function of the safety board switches

3.2.3 Motion Controllers

3.2.3.1 Motions

The CardioMD system has four independent motions:

DETECTOR ROTATE	The gear carrying the detectors can rotate over a range of 270°
DETECTOR Y	The detectors can move vertically up and down over a range of 962 mm
DETECTOR X	The detectors can move horizontally towards and away from the patient table over a range of 495 mm
TABLE LONGITUDINAL	The total travel range for the patient table is 100 mm.

All motions except table longitudinal are operated by servo motors, capable of running preprogrammed motions from the acquisition PC. The servo motors are controlled by two two-axis motion controllers. The motion controllers operate the motors through dedicated amplifiers. Figure 3.11 on page 3-16 shows the location of motion controllers and amplifiers inside the table console.

For all detector motions, relative position feedback is provided by an incremental encoder (relative encoder). On the rotate and vertical detector axis, the incremental encoder is implemented by a resolver that is an integral part of the motor connecting to the motor amplifier. The motion controllers read the incremental position from the motor amplifiers.

On the horizontal detector axis, an incremental encoder is mounted on the motor shaft (inside the motor).

For absolute position information, rotate, X and Y have absolute encoders. The signals from the absolute encoders are sent to the master motion controller and used for position calibration upon gantry power-up. The purpose of this is to index the relative encoders to a known position. After this, the motion controllers only look at the relative encoders for position feedback, but compare their outputs to the absolute encoders for verification. As long as the two encoders for each motion (with the exception of the table) agree as to the position, the motion controllers are “happy”.

The table axis has no position encoding or reporting. The table longitudinal motion is operated manually from the hand controller and works only at fixed speed.

Note. As part of the automated motions bringing the system into the patient load position, the table is automatically set to its center position.

All motions can be operated from the hand controller and also from the acquisition PC (table motion is only operated by the acquisition PC when the system is placed in the patient load position). The acquisition PC always displays the position of the detector in terms of angle of rotation, X position and Y position.

For convenience during service and installation, the detector motions can also be operated from the hand controller when no acquisition PC is connected.

3.2.3.2 Motion Control Block Diagram

Two two-axis motion controllers are used for a CardioMD system. Each axis of a motion controller is composed of:

- A control port for:
  - Motor control voltage
  - Amplifier enable output
  - Amplifier fault signal input.
- An encoder input port for incremental position information input.

The vertical drive and the rotate drive each consists of:

- A motor with resolver output
- An amplifier
- An absolute position encoder
- Ultimate limit switches
- A motion control part.

A block diagram is shown in Figure 3.9 below.

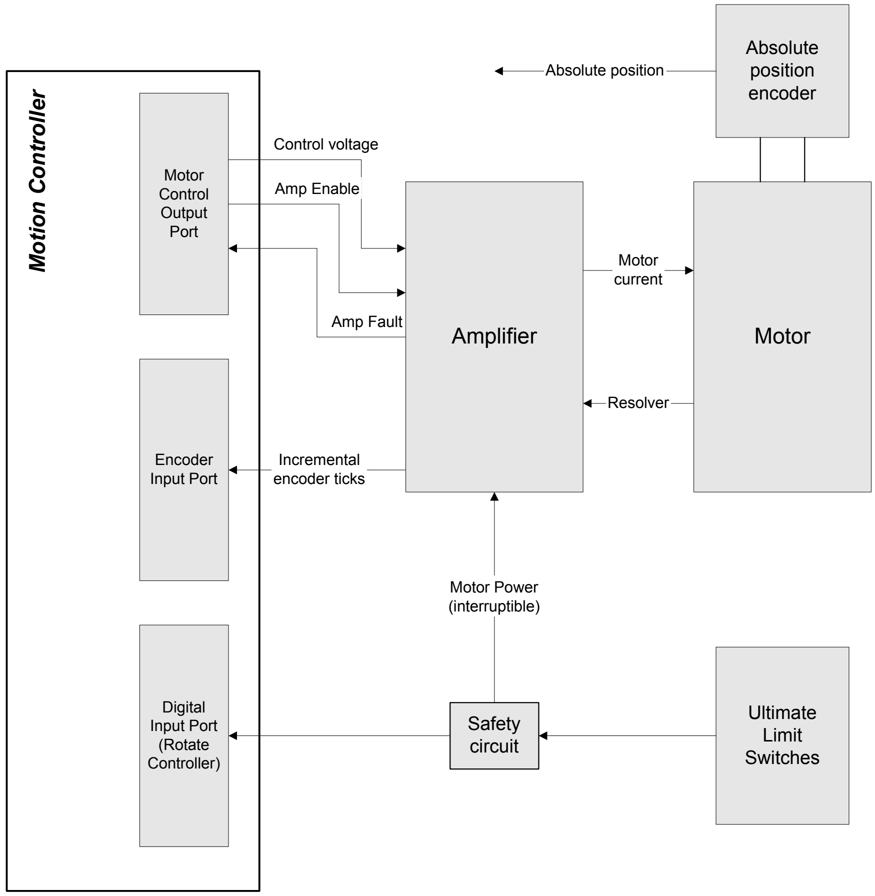


Figure 3.9 Drive block diagram

The horizontal drive differs only in the respect that the motor delivers an incremental encoder output directly instead of a resolver output.

One controller, the linear controller (the slave controller), handles the X- and Y-axis drives; the other, the rotate controller (the master controller), handles the rotate drive and the CANbus interface and thus the communication with the acquisition PC. All three absolute encoders are connected to the Rotate Controller (via the safety board), using the extraneous incremental encoder input port. The table drive uses only digital input/outputs.

The two controllers communicate via a dedicated high-speed serial interface (HSSI).

Figure 3.10 on page 3-13 shows the connections to the two controllers. The RS-232 ports are only used for debug and programming.

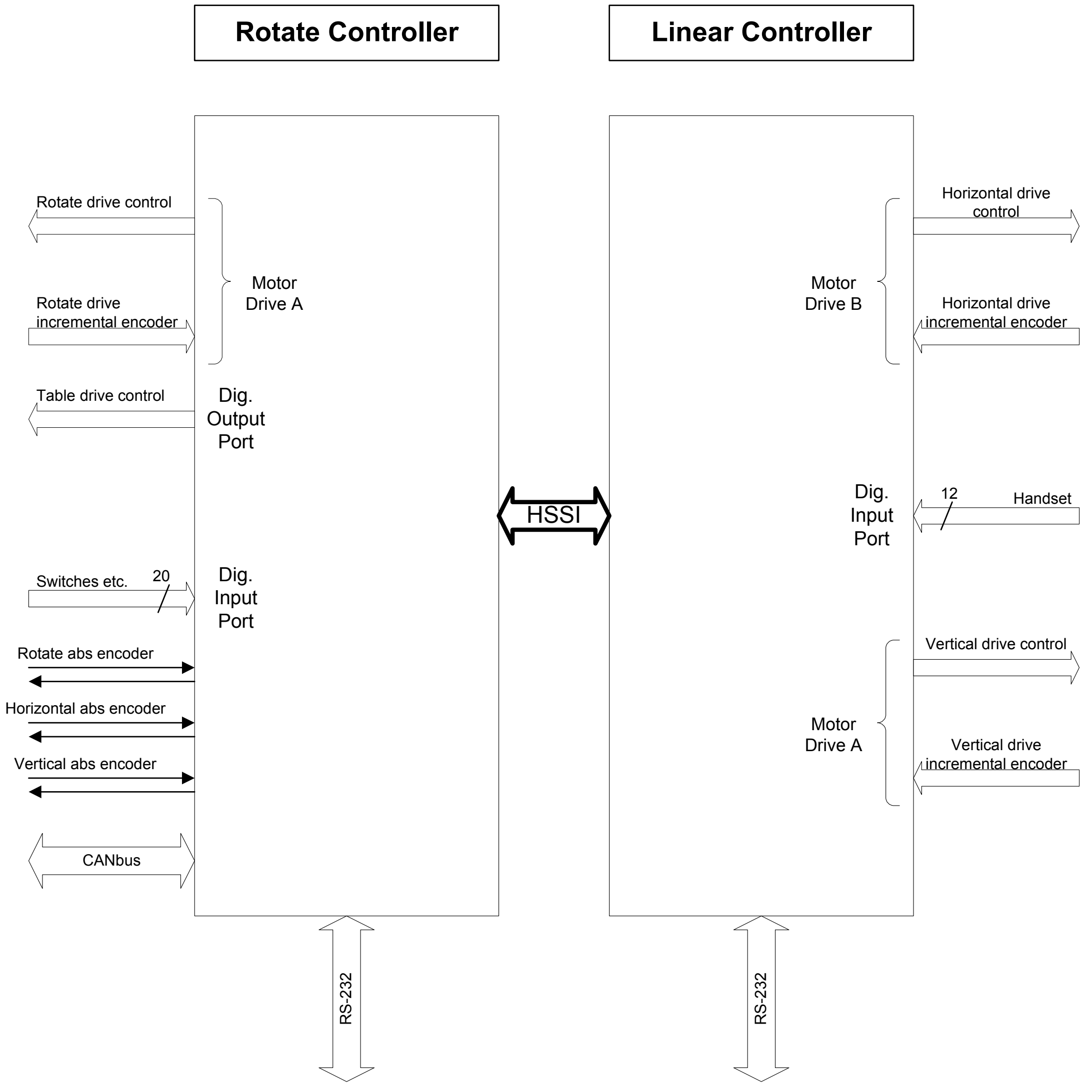


Figure 3.10 Motion controller input/output

The motion controllers receive commands, either from the hand controller or from the acquisition PC. The hand controller is connected to the Linear controller's digital input port. Further inputs – safety signals etc. – are connected to the Rotate controller's digital input port.

The communication from and to the acquisition PC takes place via one of the detector EDC boards, which translates between the PC's IEEE 1394 FireWire interface and the motion controller's CANbus interface.

The hardware of the two motion controllers is identical. The software for the two motion controllers must also be identical. A DIP switch is used to set the controller's identity (Rotate or Linear controller).

3.2.3.3 Electrical Inputs

In the motion controller I/O diagram (Figure 3.10), the following electrical inputs can be identified:

- CANbus (bi-directional) – for communication (control/status) with the EDC boards
- HSSI interface (bi-directional) – for communication between the two controllers

- Digital inputs (20 lines) – for various purposes, including hand controller input, ultimate limit switch status, collision pad status. For debugging and diagnostics of these, 5 × 10 green LED's are placed on the motion controller front
- Encoder input – for incremental encoder position input
- Motor amplifier fault indication
- Absolute encoder position inputs
- RS-232 interface – only used for debugging and diagnostics.

Furthermore each motion controller has:

- 10-pole DIP switch – for setting the CANbus address, initiation of software download, safety overrule mode and processor reset.

Table 3.4 shows the allocation of the DIP switches and Table 3.5 shows their position during normal system operation.

Switch	***Function***
SW 1 – 5	CANbus node ID (address)
SW 6	Reserved for future use
SW 7	Must be OFF
SW 8	Used for safety overrule
SW 9	Program flash (used for firmware updating)
SW 10	Reset

Table 3.4 Motion controller DIP switch allocation

CAUTION

Caution. With motion controller software release 7MOT0096-N14 and later, SW8 on the motion controllers can no longer be used.

Switch #	***Normal position on X/ Y controller (left hand side)***	***Normal position on Rotate/table controller (right hand side)***
1	OFF (Down)	ON (Up)
2	OFF (Down)	ON (Up)
3	ON (Up)	OFF (Down)
4	ON (Up)	ON (Up)
5	ON (Up)	ON (Up)
6	OFF (Down)	OFF (Down)
7	OFF (Down)	OFF (Down)
8	OFF (Down)	OFF (Down)
9	OFF (Down)	OFF (Down)
10	OFF (Down)	OFF (Down)

Table 3.5 Normal position of motion controller DIP switches

3.2.3.4 Electrical Outputs

In the motion controller connections diagram (Figure 3.10), the following electrical outputs can be identified:

- CANbus – status information and hand controller input is transmitted

- 12 digital outputs – for various purposes, including table movements
- One clock output to be used for reading of the absolute position encoders
- Motor control output ports including:
  - Amplifier enable
  - +/– 10 V motor voltage.

Furthermore, for debug and diagnostics, 5 × 10 yellow LED's are placed on the motion controller front. These LED's are further described in Chapter 5 *Diagnostics*.

3.2.3.5 Mutual Motion Controller Monitoring

The two motion controllers communicate via a dedicated high-speed synchronous serial interface. This interface is also used for mutual supervision of the proper functioning of the two motion controllers.

The Linear controller transmits the X and Y incremental encoder positions to the Rotate controller which in turn compares these to the absolute encoder positions. This ensures that the encoders are connected correctly and working properly. In this way the Rotate controller also supervises the proper functioning of the Linear controller.

The Linear controller receives regular sync messages from the Rotate controller. A watch-dog function in the Linear controller assures that these messages arrive within a certain time frame.

If either of the units detects that the other is not running properly (runaway condition), the signal OUT00 is de-activated (set HIGH). This removes all power from the motors.

However, it is possible to override this assertion (e.g. during service) by means of DIP switch SW8 (the same switch is used for overriding calibration status). There is no reset possibility, i.e. if one controller has activated the runaway signal, both controllers must be reset before normal operation can be resumed.

3.2.3.6 Motion Limits

Each detector motion axis is equipped with software limits, ultimate stop limit switches and mechanical end stops.

When the motions are correctly calibrated, the software limits are at the following positions:

Motion Axis	*Low End Stop*	*High End Stop*
Detector rotate	– 90°	+ 180°
Detector vertical	231 mm	1193 mm
Detector horizontal	0 mm	495 mm

Table 3.6 Software limits for system motions

If the detector is positioned beyond the software limits, the hardware ultimate stops will be triggered. When one ultimate limit switch is triggered, power to all motors is removed.

3.2.4 Motor Amplifiers

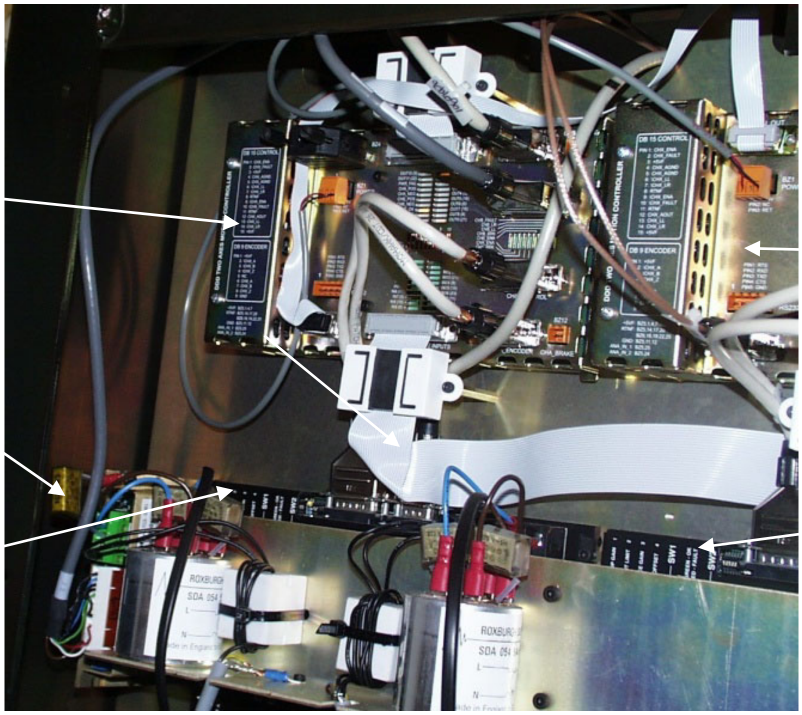


Figure 3.11 Motion controllers and motor amplifiers inside table console

Figure 3.11 shows the motor amplifiers.

Note. The X amplifier has a built-in potentiometer, which is adjusted correctly when the CardioMD is delivered from the manufacturer. Changing the setting of this potentiometer does not affect CardioMD application. Therefore, do *not* change the setting of the X amplifier's potentiometer.

3.2.5 Connections, Series III Systems

III

3.2.5.1 Rear Panel

CardioMD Series III systems have a connector panel on the rear side of the table console. See Figure 3.12 on page 3-17.

ECG Gate Power Supply

An ECG gate can be supplied from this 115 V AC output. The output is protected by a circuit breaker. A green LED in the panel shows the status of the 115 V output, which also supplies the acquisition PC.

ECG Trigger

The ECG Trigger connector is used to connect the R-wave trigger signal from the ECG gate. The gate is connected to the detector EDC boards, where the trigger pulses are detected and embedded in the FireWire event stream transmitted to the acquisition PC as time references used for the image framing process.

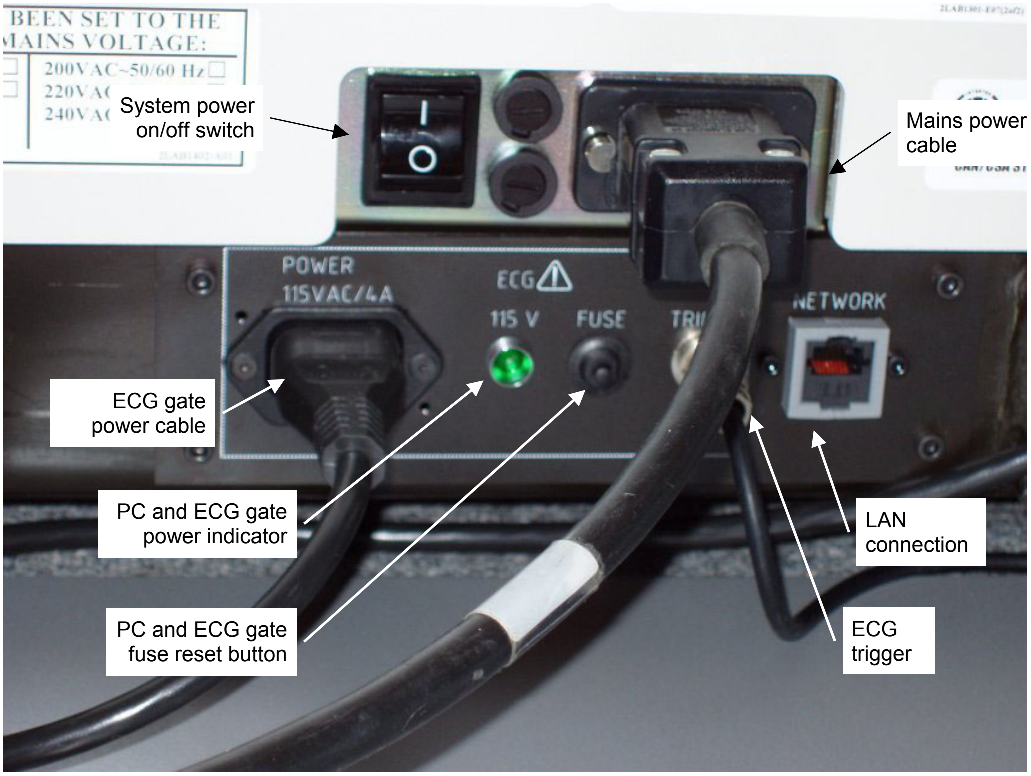


Figure 3.12 Connector panel on rear of table console (CardioMD Series III)

III

3.2.5.2 Side Panel

External

As shown in Figure 3.13, one E-Stop button is located on the side of the table console.

Figure 3.13 E-Stop button on side of table console (CardioMD Series III)

Internal

Series III systems have an internal connector panel shown in Figure 3.14.

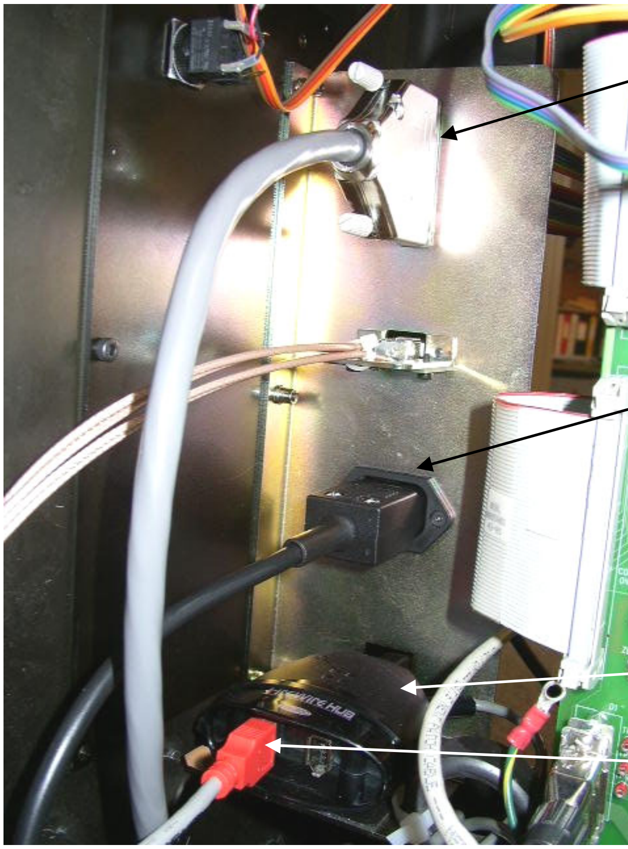


Figure 3.14 Internal side panel (CardioMD Series III)

The internal connector panel is located inside the table console and is accessible from the back of the console after removal of the console cover. The panel serves as an interface for all cables to the PC stand, with the exception of the Ethernet cable, which is routed directly to the console's rear connector panel.

The internal connector panel also includes a FireWire hub. The hub relays all FireWire communication between the detector and the acquisition PC and ensures sufficient signal integrity for all lengths of FireWire cables applied in the various PC Stand options.

III

3.2.5.3 LED Panel

Series III systems have a LED panel on the acquisition PC stand (Figure 3.15). One E-stop button is placed on top of this panel, and on the rear of the panel is the connector for the CardioMD hand controller.

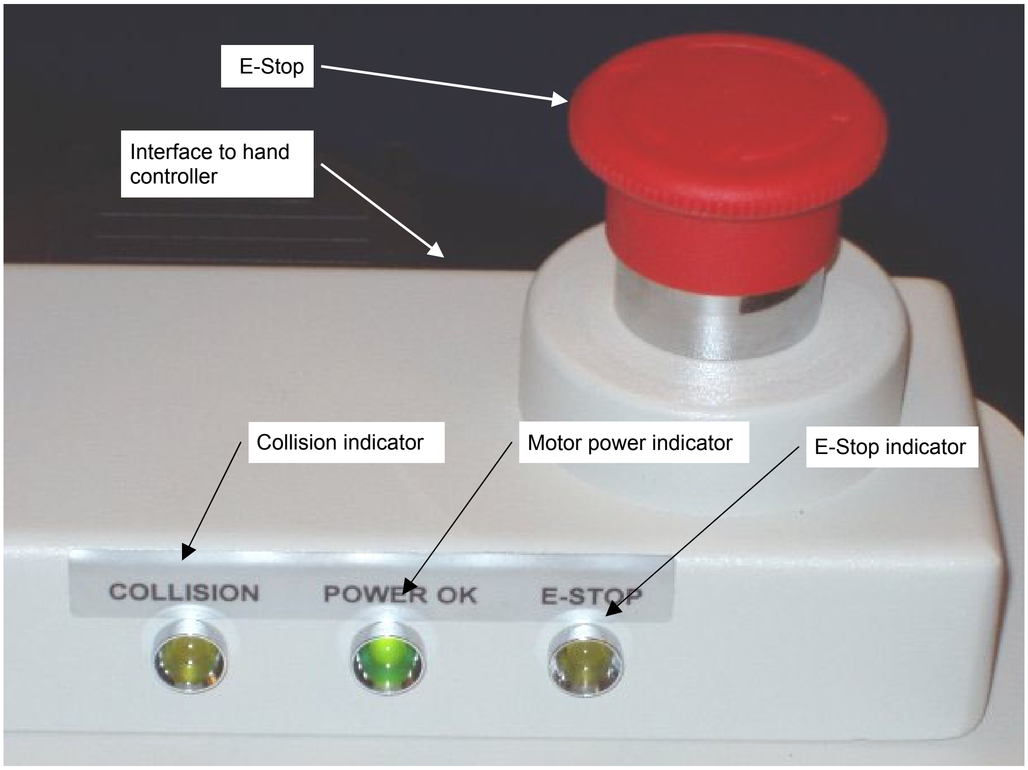


Figure 3.15 LED panel on acquisition PC stand (CardioMD Series III)

3.2.6 Connections, Series I and II systems

I, II

3.2.6.1 Side Panel

On Series I and II CardioMD systems, all connections are routed via the side panel, with the exception of mains power. Power is applied directly to the mains input located on the power supply at the rear side of the table console. The side panel is also used to connect the acquisition PC to the gantry.

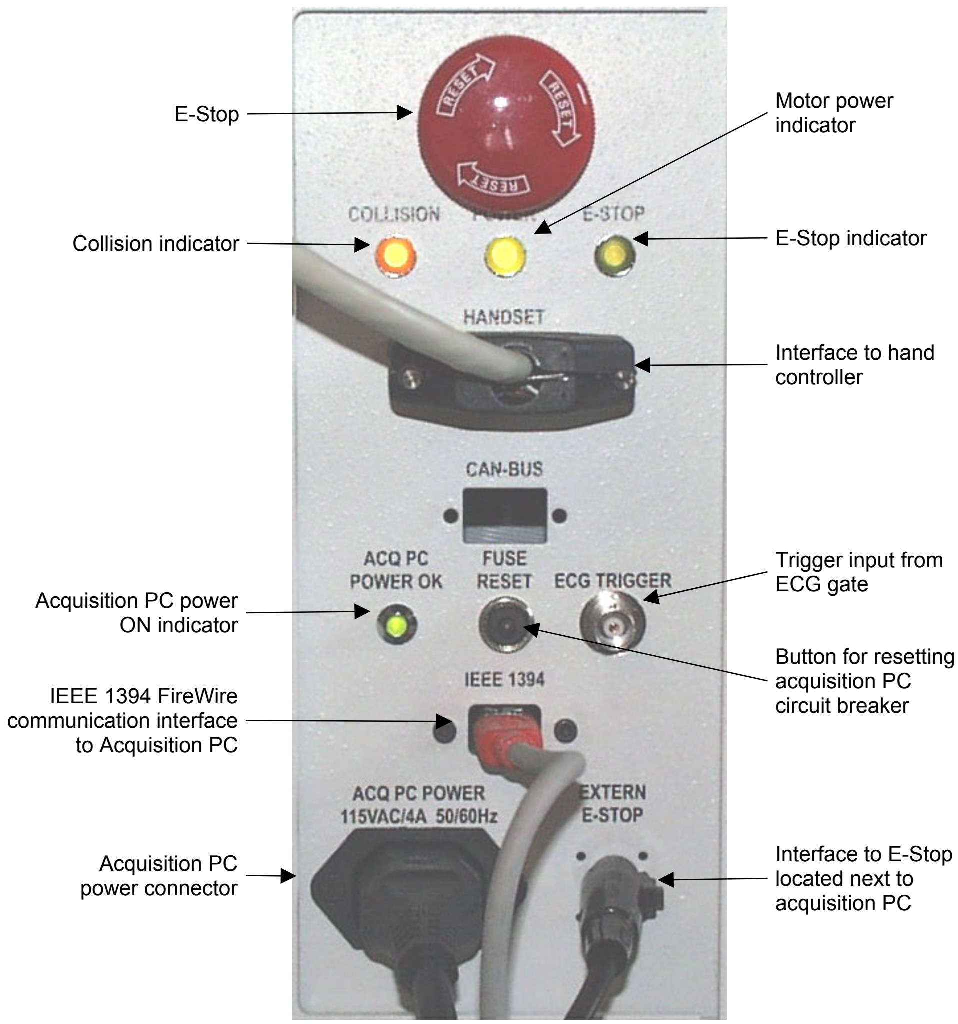


Figure 3.16 Connector panel on side of table console (CardioMD Series I and II)

Acquisition PC Power

The acquisition PC must be powered from this 115 V AC outlet. The output is protected by a circuit breaker.

IEEE 1394 (FireWire)

The IEE 1394 FireWire connector interfaces the acquisition PC to the gantry.

ECG Trigger

The ECG Trigger connector is used to connect to an ECG gate. The gate is connected to the detector EDC boards, where the trigger pulses are detected and embedded in the FireWire event stream transmitted to the acquisition PC as time references used for the image framing process.

E-Stop

One E-Stop button is located on the gantry side panel. Furthermore, a connector connects the E-Stop button located next to the acquisition PC to the safety circuit of the gantry.

Note. If the external E-Stop next to the acquisition PC is not connected, no motions are possible.

Hand Controller

The 25 pin sub-D female connector interfaces the hand controller to the safety board and motion controllers.

3.2.7 Hand Controller

The hand controller is connected to the safety board via the side panel. The Collision Override and Motion Stop signals are used directly on the safety board, where the Stop signal via a relay turns off all motion power. The Collision Override signal re-enables motion power. The Mark and Start buttons are not used by the motion controllers, only by the acquisition PC.

Motion Stop activates a stop action on the safety board and is not recognized by the motion controllers. When an Emergency Stop button has been activated, the safety board hardware requires that Collision Override is activated via the hand controller in order to resume normal operation.

The hand controller keypad (Figure 3.17) contains a number of motion keys and a number of functional keys. These are detailed in Table 3.7.

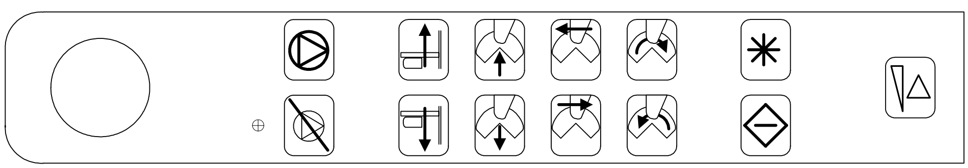
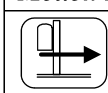
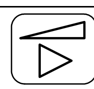
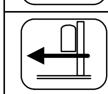
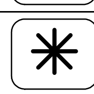
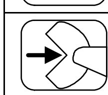
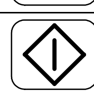
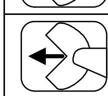
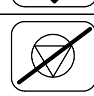
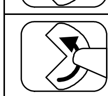
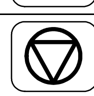


Figure 3.17 The hand controller keypad

Motion keys		***Functional keys***	
	Table out		Motion enable/accelerate
	Table in		Mark
	Detector out		Start acquisition
	Detector in		Collision override (OVR)
	Rotate CCW		Motion stop

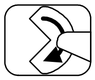
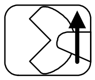
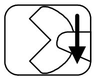
Motion keys		*Functional keys*	
	Rotate CW		
	Detector up		
	Detector down		

Table 3.7 The hand controller buttons

3.2.7.1 Collision Override

When a safety stop has been activated, the user must press the Collision Override button to activate the system again. The yellow LED on the hand controller next to the Collision Override button indicates when the use of Collision Override is required. The LED is also ON if the detectors are too close to the table or the gantry base, in which case the motor power is not interrupted.

When Collision Override and one of the motion keys are pressed simultaneously, the system starts moving at very low speed, allowing movements away from the collision.

Note. Motion is only possible after a delay of 4 – 5 seconds after motor power is re-established.

CAUTION

Caution. When Collision Override is used instead of Motion Enable, it is possible to drive the detectors into the table or the gantry base.

Both the Collision Override key and the motion key must be released before another motion can occur.

When the system has moved into a safe area (that is, where a collision is no more detected), it is possible to use the Motion Enable key again.

3.2.8 Safety Circuit

A hardwired safety circuit controls all motion power. Motion power consists of 180 V DC for Rotate and Y drive, 55 V DC for X drive and 24 V DC for table drive. These three voltages are passed through a relay inside the main power supply. The relay itself is powered from a 24 V loop, running through the external E-Stop Buttons and relays on the safety board.

3.2.8.1 Safety Stop Scenarios

Scenario	*Indications*	*Recovery action*
Collision on collimator, detector or gearbox	Collision indicator LED is ON Hand controller Override LED is ON Motor power indicator LED is OFF	Press hand controller Collision Override button, together with the relevant motion button and back out of the collision
Rotate, X or Y axis reached ultimate limit	Motor power indicator LED is OFF Red ULT_STOP LED on safety board is ON	Typically, this condition is caused by incorrect adjustment of one of the ultimate stop switches or one of the absolute encoders. Green LED's on the safety board indicate those switches not activated. Please observe that the LED's are connected in series: If the Y switch is active (the LED for vertical is OFF), the X and rotate

Scenario	*Indications*	*Recovery action*
		LED's will also be OFF. If the X LED is OFF, the rotate LED will also be OFF. For adjustment of the ultimate end stop, see Chapter 4 *Calibration*
RUNAWAY signal issued by a motion controller	Motor power indicator LED is OFF RUNAWAY LED on safety board is ON OUT 00 LED on a motion controller is OFF	This is considered a serious problem with a motion controller or position encoder. The cause may be a faulty motion controller, a faulty absolute encoder, a faulty motor amplifier (Rotate and Y axis), a faulty motor or a cable problem. The problem must be identified and fixed first. To recover, reset both motion controllers and press the Collision Override button on the hand controller
Hand controller Stop button pressed	Motor power indicator LED is OFF RUNAWAY LED on safety board is OFF	Press hand controller Collision Override button
E-Stop button activated	E-Stop indicator LED is ON	Turn the relevant E-Stop button clockwise to release it and press the hand controller Collision Override button

3.2.8.2 Safety Circuit Block Diagram

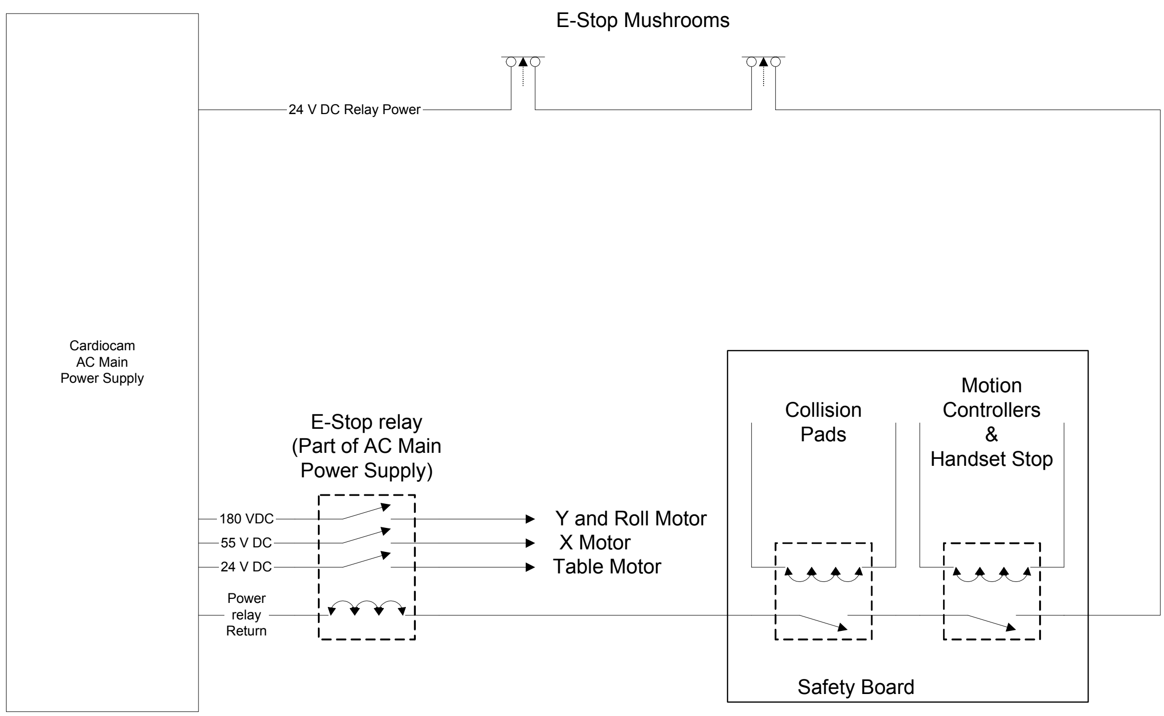


Figure 3.18 Safety circuit block diagram

3.3 Detectors

3.3.1 General

The CardioMD detectors are based on a unique technology that provides superior performance in a rather simple design. The photomultipliers – PMT's – employed are 3" square; a total of 24 PMT's are arranged in a 6 × 4 rectangular pattern in each detector. Each PMT has an integrated preamplifier and automatic gain stabilization based on a built-in LED.

Position and energy information is summed and preprocessed in an analog circuitry directly on the outputs from the PMT's. From that circuitry, the information is passed on to a group of A/D converters and, from here on, all processing is digital. The output from the detector is fully corrected, digital image data transferred event by event on a serial interface. The serial interface employed is IEEE 1394 FireWire.

The entire detector is powered from 55 V DC. A power supply inside the detector provides supply voltages for the analog circuitry and a negative high voltage for the PMT's.

3.3.2 Automatic PMT Gain Control – Autotune

For gain control of the individual PMT's, a light reference (LED) is built into each PMT. This LED flashes for 3 µsec every 10 msec, and the response from the PMT is sampled and compared to a reference voltage. The output from the comparator is fed into a gain control circuit on the PMT. In this way a closed loop ensures that the response from the reference light (the LED) always corresponds to the reference voltage. The reference voltage is set up from a DAC that is dedicated for each PMT. The individual PMT gain settings can now be digitally controlled.

The output from the comparator is also used as information about the gain margin of the PMT (working point).

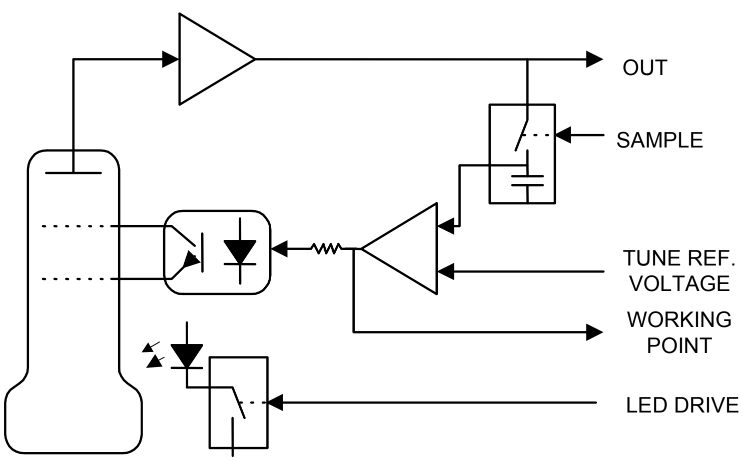
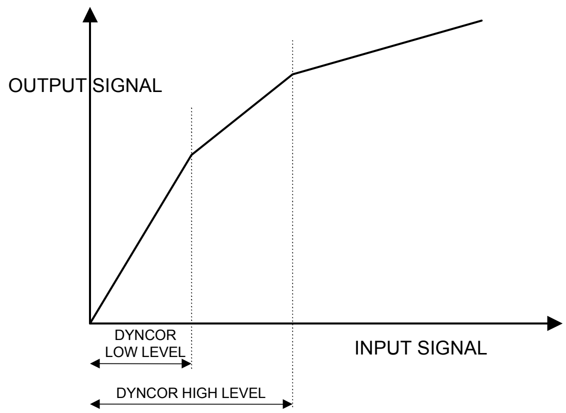


Figure 3.19 Auto tune circuit

3.3.3 Dynamic Linearity Correction – DynCor

DynCor provides a non-linear relationship between the group sum and the position of the scintillations. This non-linearity compensates for a distortion in the photon optics between the crystal and the PMT's.



The nonlinear transfer function is characterized by two break points, HIDYN and LODYN. The levels of these break points are always proportional to the energy of the events. The relative levels are set by a value in the tuning tables. These values are factory set and not subject to field adjustments

3.3.4 Detector Layout – Outside

Immediately under the top cover are the detector power supply and the two EDC boards.

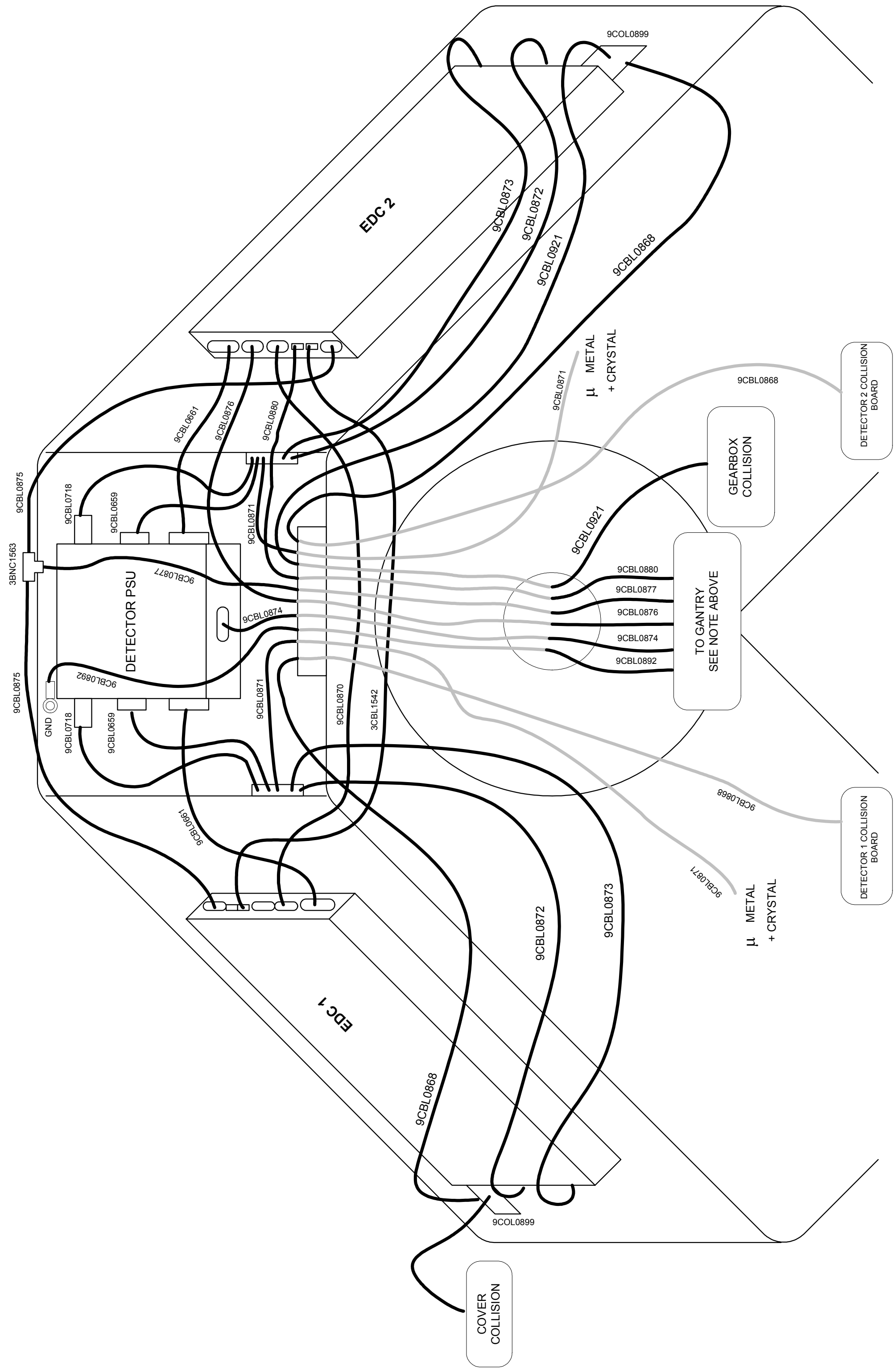


Figure 3.20 Detector layout under top cover

3.3.4.1 Detector Power Supply

The detector power supply receives the 55 V DC power through the detector cable. The 55 V are used to generate 4 low voltages: +15 V, +5 V, –5 V, –15 V and a negative high voltage adjustable to – 1500 V max.

A separate 55 V supply is transferred through the detector power supply to the EDC boards for their power requirements.

The master EDC board (located on detector 1) controls the high voltage, which is common to both detectors, and it receives diagnostic information from the detector power supply.

3.3.4.2 EDC Board

The Event Digitization and Correction – EDC – Board is the intelligent core of the detectors. It handles a number of tasks:

- It handles all FireWire communication between the acquisition PC and the gantry.
- It (the master EDC board) handles the communication between the FireWire from the PC and the CANbus to the motion controllers.
- It (the master EDC board) controls the high voltage and reads diagnostic information from the detector power supply unit.
- It writes tuning values to the tune DAC's and drives the autotune circuits.
- It writes gain values to the control DAC's for DynCor and threshold.
- It reads PMT working point values from the PMT's.
- It synchronizes gated acquisitions with external ECG monitor.
- It detects collision on collimator and detector and reads the collimator ID.
- It reads the ID code specific for the individual detectors.
- It digitizes the four position signals and the Energy signal from the X-E strip (X+, X– and Energy) and the Y strip (Y+ and Y–).
- It applies spatial and energy corrections based on downloaded tables.

3.3.5 Detector/Collimator ID Boards

On the detector front, facing the collimator is a small board with five spring contacts. The detector ID EEPROM is located on the backside of that detector/collimator ID board. The board also serves as interface to a similar board with spring contacts on the collimators. The boards on the collimators carry the collimator ID EEPROM.

3.3.6 Analog Boards

The analog boards are located below the bronze-lead covers under the EDC Boards.

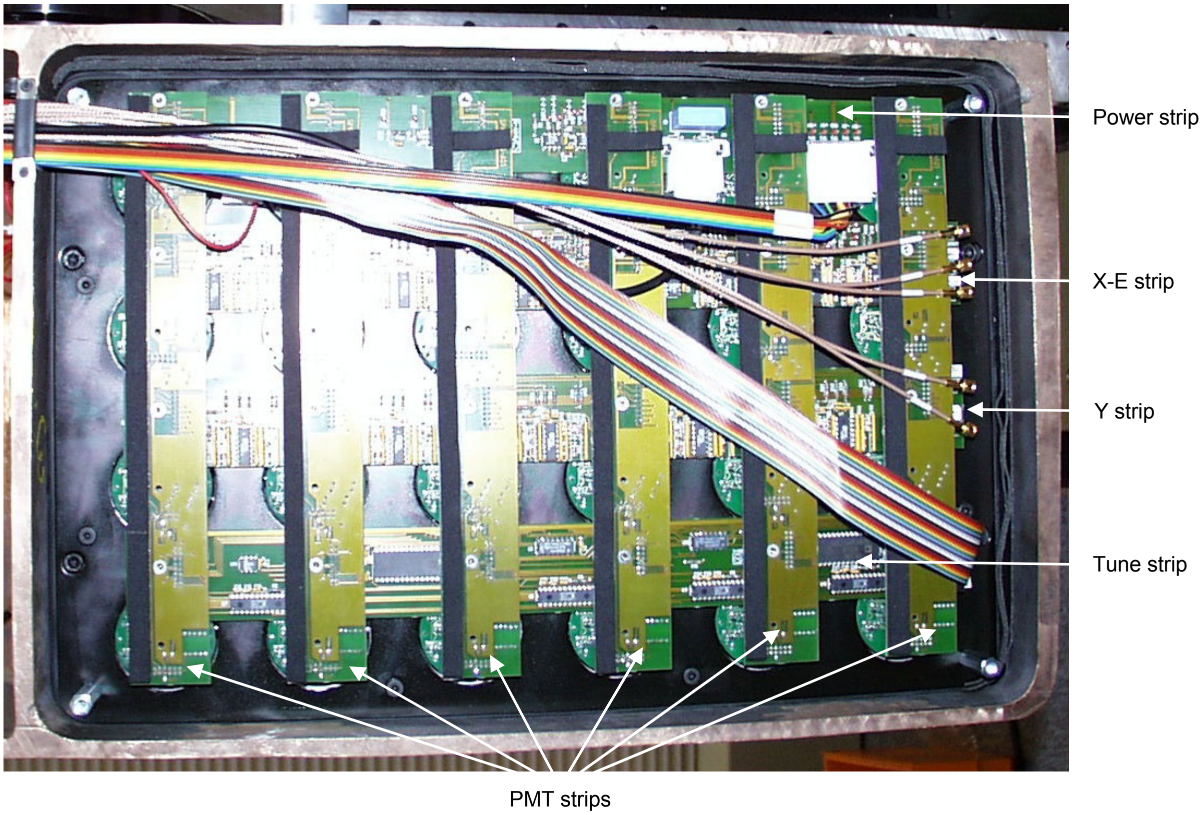


Figure 3.21 Location of analog circuitry

3.3.6.1 PMT Strips

The PMT Strips are passive boards interconnecting four PMT's each. They transfer power supply voltages, including high voltage, autotune drive signals, tune reference voltages, working point signals and control voltages for DynCor and threshold.

3.3.6.2 X-E Board

The X-E board sums the output from seven overlapping groups of PMT's in the X direction. Each group sum is subjected to a DynCor process, and after that, a threshold is applied in order to exclude those groups that are far away from the scintillations to eliminate noise. The information from those groups is too noisy due to low photon statistics.

After threshold discrimination, the seven group sums are fed into a resistor matrix which feeds into two summing nodes, X+ and X–. The resistor values of the matrix are such that the difference between X+ and X– changes linearly with the X-positions of the scintillations.

The X-E board also provides an undiscriminated sum of all PMT signals which represents the isotope energy.

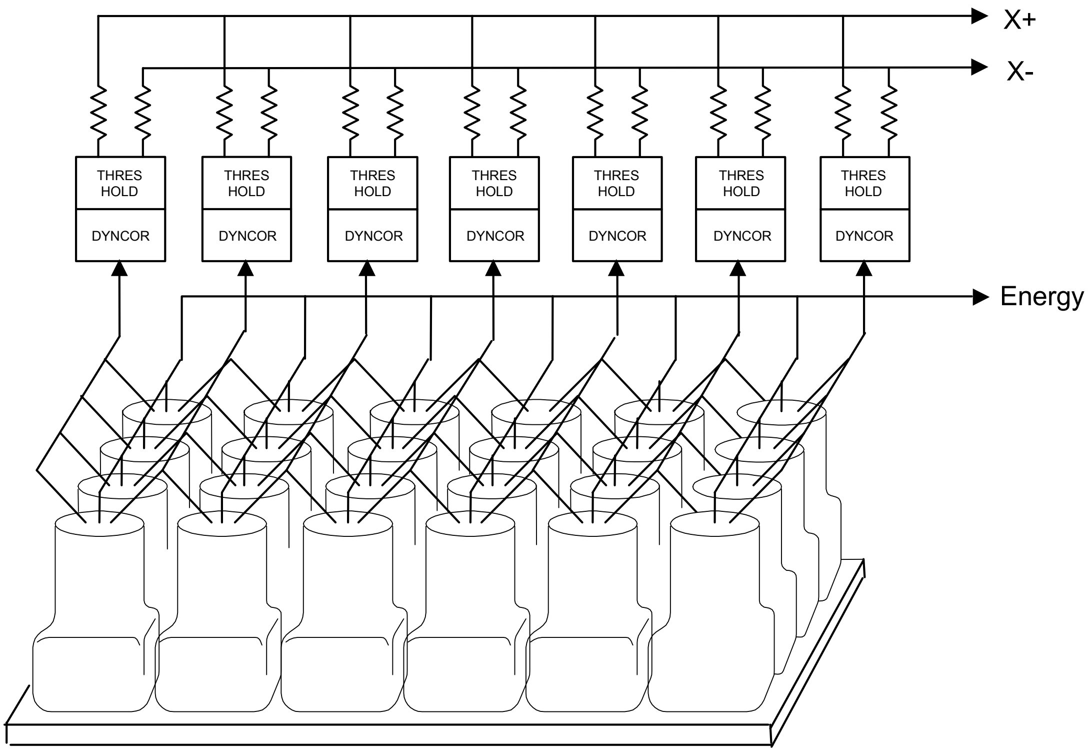


Figure 3.22 Schematic of the X-E board

The X-E board also carries the drivers for DynCor and threshold signals. These signals are copies of the energy signal and are adjustable in amplitude. The amplitude adjustments are performed in analog multipliers, controlled by DC voltages from dedicated DAC's on the tune board.

The digital values written to the DAC's are contained in the tuning tables.

Note that the analog multipliers are supplied from +5 V and –5 V linear regulators located on the Y board.

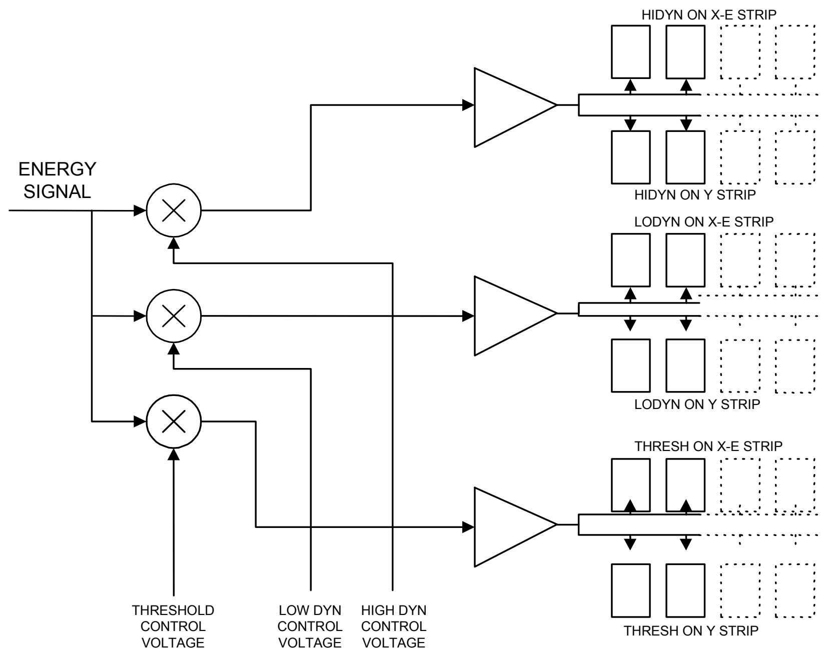


Figure 3.23 Schematic block diagram of DynCor- and threshold drivers

3.3.6.3 Y Board

The Y Board sums the output from five overlapping groups of PMT's in the Y direction. Each group sum is subjected to a DynCor circuit succeeded by a threshold similar to that on the X-E board.

The five group sums are fed into a resistor matrix which feeds into two summing nodes, Y+ and Y−.

Note that the Y board also carries a +5 V linear regulator and a –5 V linear regulator that supplies the analog multipliers on the X-E board.

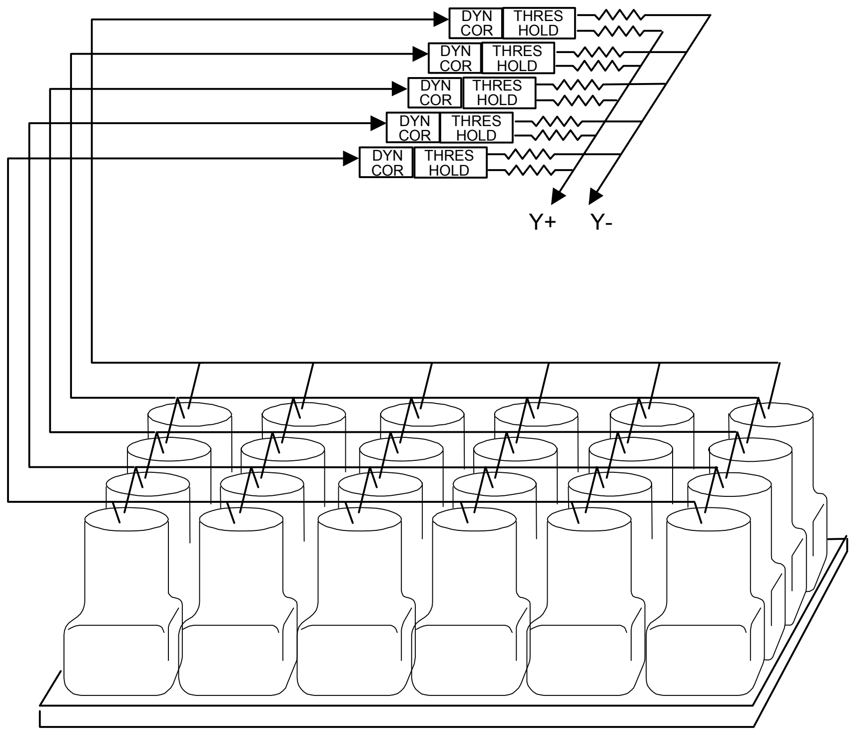


Figure 3.24 Schematic of the Y-board

3.3.6.4 Tune Board

The tune board carries three octal 10-bit DAC's. On the basis of the tuning tables, the DAC's provide the reference voltages for the autotune circuits in the 24 PMT's and the control voltages for the DynCor and threshold multipliers.

The tune board also carries a 24-to-one multiplexer and a D/A converter, enabling digital read-out from the working points in the 24 PMT's.

3.3.6.5 Power Board

The power board distributes high and low voltages to the six PMT interconnecting strips. It also carries driver circuits for the autotune.

3.4 Acquisition PC

3.4.1 Tower Acquisition PC

I, II

The acquisition PC of CardoMD Series I and II systems is a tower PC with the following minimum specifications:

IBM compatible, 550 MHz, ATX, 512 kb CPU RAM, 128 Mb SDRAM PC100, 15 Gb Hard Disk, 3.5" Floppy drive, 40x speed CD-ROM drive, 16 Mb Graphics (Matrox G400), and EtherNet adapter (3COM XL PCI 10/100BTX).

The PC has an IEEE 1394 FireWire interface.

The PC software operates under Microsoft Windows 2000.

Newer PC's are equipped with a CD R/W drive. The CD R/W drive can be used for backing up calibration data and user-defined acquisition protocols.

3.4.2 Laptop Acquisition PC

III

Series III CardioMD systems are supplied with a laptop acquisition PC with the following minimum specifications:

IBM compatible, 1.5 GHz (Pentium M), 8 Mbyte CPU RAM, 256 Mb SDRAM PC100, 40 Gbyte hard disk, DVD-CD R/W drive, 32 Mb Graphics (1024 × 768), EtherNet adapter (PCI 10/100BTX), IEEE1394 FireWire interface, 2 × USB 2.0, 15” TFT monitor.

The PC software operates under MicroSoft Windows XP.

3.4.3 PC Connections

The acquisition PC must be powered with 115 V from the gantry.

I, II

On Series I and II systems, acquisition PC signal connections are the following:

- FireWire. The cable between the acquisition PC and the gantry contains a FireWire cable, which is connected to the PC’s FireWire interface and to the Firewire connection on the gantry connector panel.
- Local area network (ethernet). A standard network cable with RJ45 connectors connects the PC to the local area network. The cable between the acquisition PC and the gantry contains the network cable, which ends in an RJ45 female connector near the gantry connector panel.
- E-Stop. A two-wire cable connecting the Emergency Stop button located next to the acquisition PC to the gantry.

III

On Series III systems, acquisition PC signal connections are the same (power, FireWire, LAN, E-Stop), plus signals for the Collision, Power OK and E-Stop LED’s next to the laptop PC. However, all connections are internal to the gantry.

The gantry must be connected to the local area network via the connector on the rear panel of the table console (see Figure 3.12, page 3-17).

4 CALIBRATION

Contents

4.1 Introduction

This section describes all calibrations necessary to the CardioMD system.

4.2 Detector Calibration

4.2.1 Detector Calibrations Overview

All detector calibrations are performed electronically and activated by menu selections on the acquisition PC.

Before starting calibration, make sure that high voltage has been applied for a period of time. If power has been removed for more than a 15 minute period, the high voltage must be applied for an equal period before calibration can be started. The maximum warm-up period required is 5 hours. The detector electronics must also have at least 15 minutes with the cover installed, to reach operating temperature. Fluctuations in temperature (increase or decrease) can cause calibrations to drift as the detectors reach operating temperature.

A complete calibration may be necessary after replacement of following detector parts:

- EDC board
- PMT
- X-E board
- Y board
- Crystal.

A complete calibration of a CardioMD detector involves the steps listed in Table 4.1.

Note. The shaded rows indicate the calibrations required at time of installation.

# *)	***Calibration***	***Equipment***	***Isotopes (point sources)***	***Approx. duration per detector***
1	HVCal (high voltage calibration)	N/A	N/A	3 min.
2	PMTCal (PMT basic calibration)	Point source holder	Tc-99m or Co-57 ~ 40 MBq or 1 mCi	10 min.
3	Ecal (energy calibration)	Point source holder	Tl-201, Ga-67 or Ba-133 and Tc-99m ~ 40 MBq or 1 mCi	5 min.
4	GeoCal (geometry calibration)	MWSR mask, 4 collimated source holders	4 sources, Tl-201, Ga-67 or Ba-133 ~ 4 – 12 MBq or 0.1 – 0.3 mCi each	5 min.
5	PMTCal update	Point source holder	Tc-99m or Co-57 ~ 40 MBq or 1 mCi	5 min.
6	ECor (energy correction map calibration)	Point source holder	Tc-99m or Co-57 ~ 40 MBq or 1 mCi	30 min.
7	LinCor (spatial linearity map calibration)	Linearity phantoms Point source holder	Tc-99m or Co-57 ~ 120 – 200 MBq or 3 – 5 mCi	60 min.

# *)	*Calibration*	*Equipment*	*Isotopes (point sources)*	*Approx. duration per detector*
(8)	UnifCor (isotope specific uniformity calibration)	Point source holder (or flood phantom)	As desired ~ 40 MBq or 1 mCi (intrinsic) ~ 120 – 200 MBq or 3 – 5 mCi (extrinsic)	15 min.
9	CorCor (center of rotation calibration)	Point source	LEHR: 40–120 MBq or 1–3 mCi LEGP: 40–120 MBq or 1–3 mCi	15 min.

Table 4.1 Complete CardioMD calibration

*) **Note**. The calibrations are interdependent in a hierarchical order. Any calibration in the sequence must be preceded by all calibrations that have lower numbers. For example, before performing ECor, all other calibrations preceding ECor in Table 4.1 must have been done.

Note. Before you are allowed to perform detector calibrations, you must enter a password. The procedures described in the following sections identify when this is required. Once the password has been entered, you will not need to re-enter the password for the remaining calibrations. All menu options on the acquisition PC will remain enabled until you exit the CardioMD application software.

Note. When you have completed the detector calibrations, remember to close down and then restart the CardioMD application software. This will disable access to the service calibration menu options.

Note. Detector calibrations are saved as correction files on the acquisition PC. When any detector calibration is performed, the corresponding correction file must *not* have the attribute read-only, as would be the case if the correction file for some reason has been copied from a CD-ROM. Therefore, before starting detector calibrations, verify that the calibration files involved do not have the read-only attribute: Right-click on the file in the Windows Explorer and ensure that the Read-only box is *not* checked. Names of calibration files are listed for each calibration procedure described in this chapter.

If the existing correction file has the attribute read-only, a pop-up message is displayed when the calibration is started. In this case, correct the attribute of the correction file: Right-click on the file in the Windows Explorer and un-check the Read-only box.

Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed and the system configured to run without the AC option before the following calibrations and tests can be performed:

- HVCal (high voltage calibration)
- PMTCal (PMT basic calibration)
- Ecal (energy calibration)
- GeoCal (geometry calibration)
- ECor (energy correction map calibration)
- LinCor (spatial linearity map calibration)
- All NEMA tests (see Chapter 10 *NEMA Performance Measurement*).

See Chapter 12 *CardioMD AC Option* for instructions on removing the transmission scanners.

4.2.2 Checks Prior to Calibrations

Before performing any detector calibrations, the power supplies and background radiation should be checked.

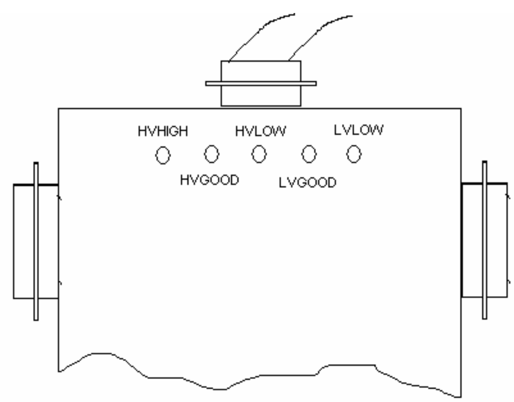
4.2.2.1 Power Supply Check

The detector power supply receives the 55 V DC detector power through the detector cable. The 55 V is used to generate four low voltages: +15 V, +5 V, –5 V, –15 V and a negative high voltage adjustable to –1500 V max. The 55 V is also transferred to the EDC boards for their power requirements.

The power supply check procedure requires you to check the detector's low & high voltage sources via LED indicators on the power supply and EDC board.

Note. The PMT's require a warm-up period of 24 hours to stabilize, once power is applied for the first time during installation. References to other waiting periods in this procedure apply *after* this initial warm-up period. If power has been removed for more than a 15 minute period, high voltage must be applied for an equal period before calibration is started. The detector electronics must also have at least 15 minutes with the cover installed to reach operating temperature. The maximum warm-up time required is 5 hours.

Procedure

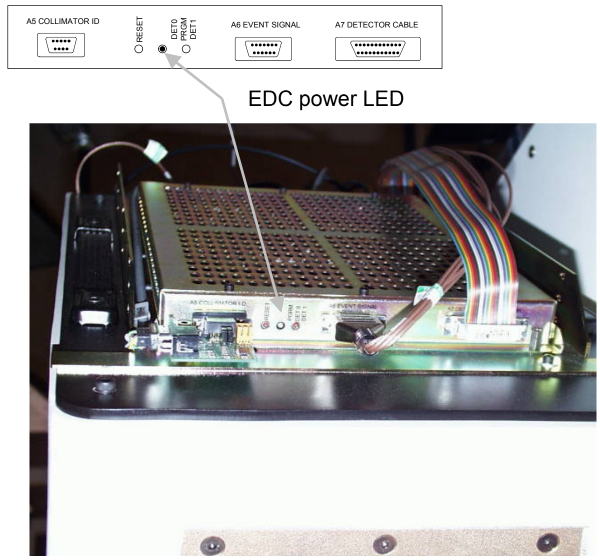
Procedure	***Details***
1. Remove the detector top cover. Five LED's inside the detector power supply provide information about the integrity of the output voltages. The LED's are visible through the perforations of the top cover. Their significance is explained in Table 4.2.	 Location of LED's on the Detector Power Supply

LED Name	***Color***	***Signifies***
HVHIGH	RED	High voltage higher than specified setting
HVGOOD	GREEN	High voltage at specified setting
HVLOW	RED	High voltage lower than specified setting or not enabled
LVGOOD	GREEN	All low voltages in specified range
LVLOW	RED	One or more low voltages lower than specified range

Table 4.2 Significance of LED's on detector power supply

Note. If the HVCal tables have not been loaded to the detector, the red HVLOW LED may be lit. This is normal. The power supply must have HVCal table loaded before the HVGOOD LED is lit. HVCal tables are automatically loaded when the CardioMD application is started on the PC.

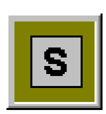
Checking LED's on EDC Boards

Procedure	*Details*
A LED is located on the rear panel of each of the two EDC boards. These LED's indicate when power is applied to the EDC boards.	
2. Reinstall the detector top cover and allow the detector internal temperature to stabilize for 15 minutes.	

4.2.2.2 Background Noise Check

Before introducing any sources to the area, you must check that there is no major background radiation present that could cause erroneous data during certain calibrations.

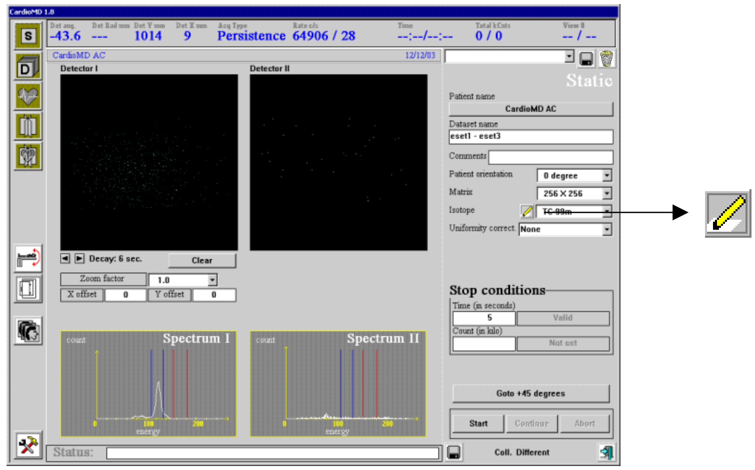
Do check background radiation:

Procedure	*Details*
1. Verify that there are no unshielded sources of radiation in the room.	
2. If collimators are mounted on the system, remove both collimators.	
3. On the CardioMD application's Persistence page, click the Static button.	

Procedure	***Details***

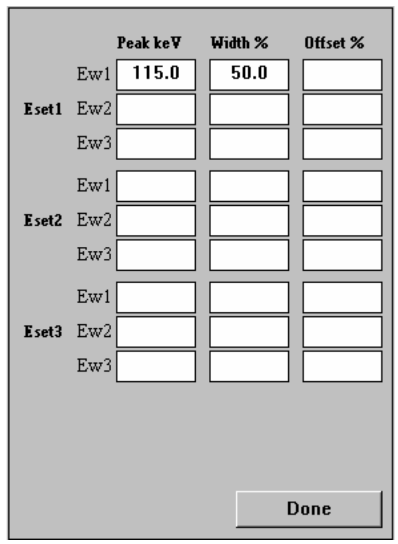
The Static Acquisition page appears.

4. Click the 'Pencil' button in the right-hand side of the page.



The energy pop-up appears.

5. Set Peak keV to 115 and Width % to 50.
6. Click Done to close the energy pop-up.



7. Click Start to begin the acquisition.

The count rate now reflects the background activity. Count rate information is provided in the Rate c/s field at the top of the window.

8. Verify that the counts do not exceed 300 counts per second per detector.

Note. If the count rate exceeds this level, attempt to determine the cause of the excessive count rate. Take steps to shield the detector appropriately so as to ensure that the excessive counts do not to affect calibrations.

4.2.3 High Voltage (HV) and PMT Calibration (PMT)

4.2.3.1 Description

A basic alignment of the PMT's is necessary as a first step.

The PMT calibration program may start by loading previous tuning values. In that case, the calibration is referred to as an update tune.

However, if a detector is being tuned for the first time, a basic calibration must be performed and default values will be loaded. Subsequently, the high voltage is adjusted to a relatively low value and then moves upwards in steps. For each HV step, 10 seconds are allowed for the autotune to lock in on those tubes that have reached their lower working limit. Also for each HV step, the working point for each PMT is monitored. The HV continues to step upwards until all PMT working points are in their dynamic range. From that step, the HV is increased by another 50 V to ensure all PMT's are in sufficient gain range. The HV value is then stored in the tuning file.

Following the basic alignment of the PMT's, a series of iterative flood images are acquired as dual energy acquisitions with two energy windows around the specified isotope energy. The images are spatially subdivided into regions, each representing the outline of a PMT. For each iteration, the count rate for all PMT regions in both the low and the high energy window are compared individually and, if they are not equal, that tube gain is adjusted accordingly.

When equilibrium has been reached for all tubes, the PMT tuning file is stored with the final tuning values.

4.2.3.2 High Voltage Calibration Procedure

To be performed:	At installation and when the EDC board, PMT tube or crystal is replaced.
Detector:	Both detectors at the same time, with or without collimators.
Source:	None.
Total calibration time:	Approximately 3 minutes.
Calibration file created:	`C:/Cardiocam/calibrations/hvcal.dat`.

WARNING

The high voltage is common to both detectors. Changing the high voltage setting may affect all other calibrations of *both* detectors entailing a need for a complete re-calibration of the other detector.

After performing a high voltage calibration, as a minimum perform a PMT update and a QC check of the other detector.

If GeoCal is required on one detector following high voltage calibration, perform a GeoCal on the other detector, as well.

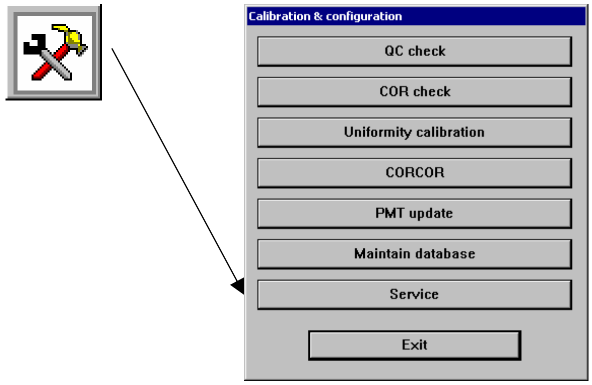
Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed before high voltage calibration can be performed. See Chapter 12 *CardioMD AC Option* for instructions.

Procedure | ***Details***

1. On the acquisition PC's Persistence page, click the Tools button.

The Calibration & Configuration menu appears.

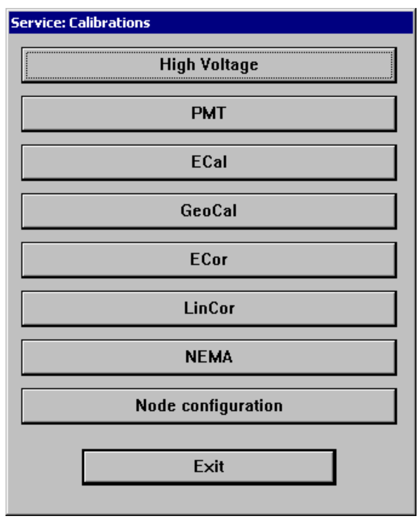
2. In the Calibration & Configuration menu, click Service.



3. When prompted, enter the service password (currently DDD) and click OK.

The Service Calibrations menu appears.

4. Click the High Voltage button.

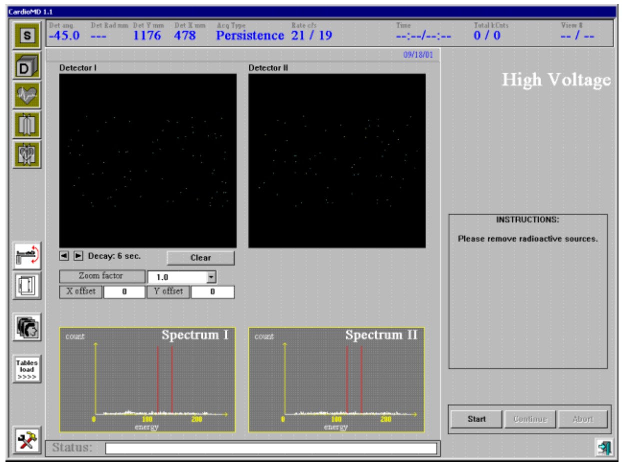


Note. If the CardioMD AC option is installed on the system, all buttons of the Service menu, except the Node configuration button, are greyed out. The transmission scanners must be removed and the system configured to run without the AC option before any service calibrations can be performed. See Chapter 12 *CardioMD AC Option* for instructions on removing the transmission scanners.

Procedure	***Details***

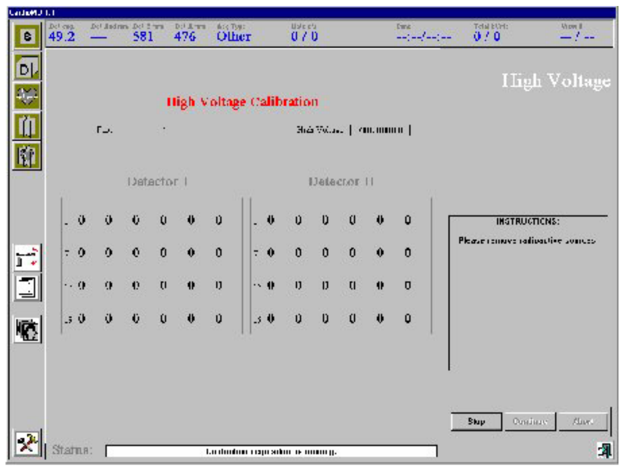
The High Voltage Calibration page appears.

5. Ensure that all radioactive sources are removed.
6. Click Start to begin the calibration.



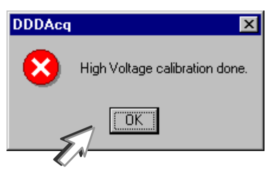
The display shows the PMT working values that are being read at the EDC board.

The HV continues to step upwards until all PMT's have their autotune control loop in their dynamic range, which is reflected by the work point value. Once this has taken place, the HV is increased by another 50 V to ensure that all PMT's have sufficient gain range. The HV value is stored on the acquisition PC.

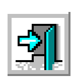


When the High Voltage calibration is complete, a message appears indicating that the high voltage calibration is done.

7. Select OK to close the message.



8. Click Exit to close the High Voltage page.



4.2.3.3 PMT Calibration Procedure

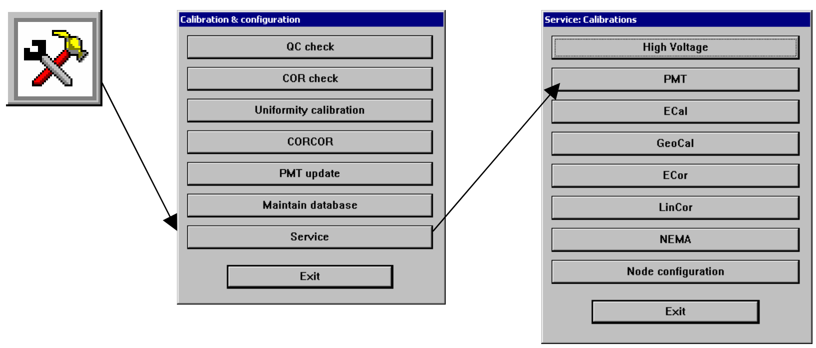
To be performed:	At installation, and when the EDC board, PMT tube, X-E board, Y board or crystal is replaced.
Detector:	One detector at the time, without collimator.
Source:	Tc-99m or Co-57. 40 MBq or 1 mCi in the source holder.
Total calibration time:	Approximately 10 minutes per detector.
Calibration file created:	`C:/Cardiocam/calibrations/pmtcal.det1` and `det2` respectively.

Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed before PMT calibration can be performed. See Chapter 12 *CardioMD AC Option* for instructions.

Note. The detector cover must be in place and the detector electronics must be at normal operating temperature before this procedure is started.

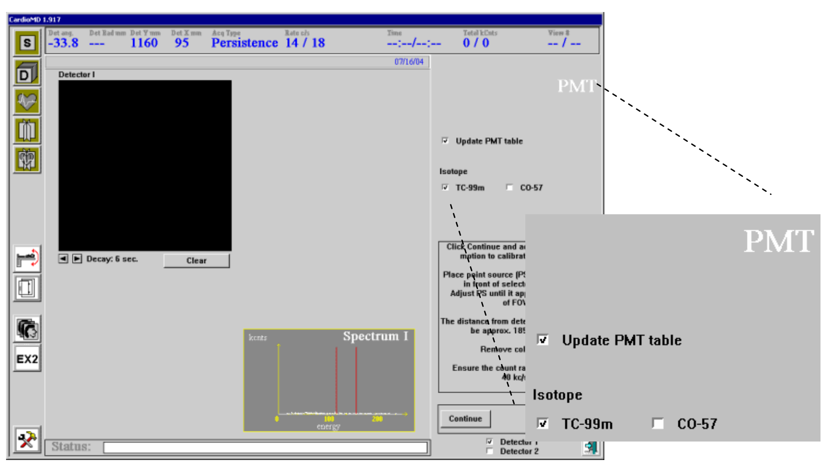
Procedure	***Details***

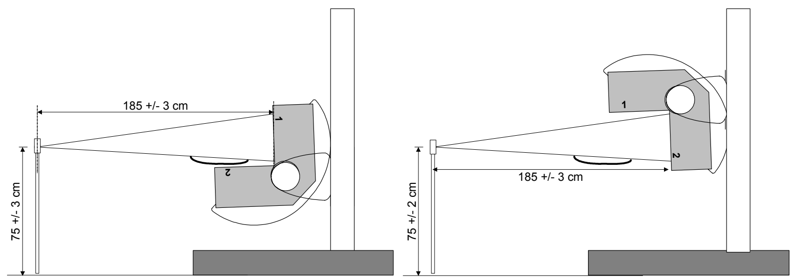
1. Ensure that the CardioMD system is in the patient load position.
2. On the Persistence page, click the Tools button.
3. When the Calibration & Configuration menu appears, click Service.
4. If prompted, enter the service password (see page 4-9 for instructions).
5. In the Service Calibrations menu, click PMT.



The PMT page appears.

6. Unless a major repair requires a tuning from scratch, select Update PMT table.
7. Select the appropriate isotope (either Tc-99m or Co-57).
8. Select detector 1 or detector 2 to be calibrated.



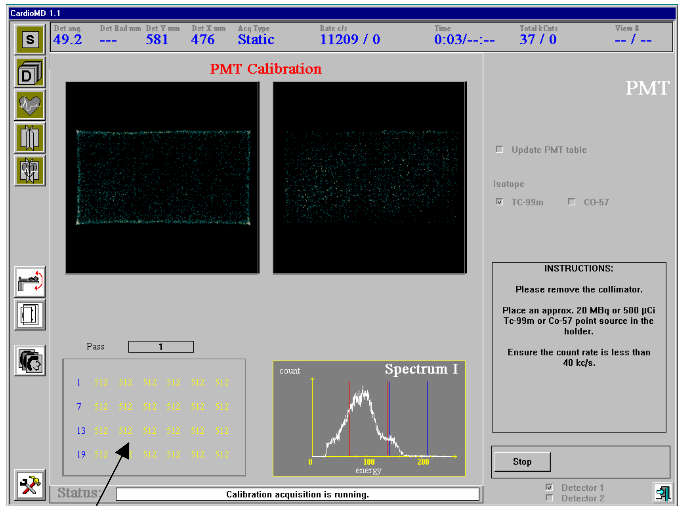
Procedure	Details
Note. An update is also required after performing GeoCal.	
Note. The customer will perform a PMT update if a uniformity QC check is not acceptable.	
9. Click Continue.	
Note. Automated motions must be started from the patient load position.	
10. Place the point source holder at a distance of approximately 1.85 meters (6 ft.) from the detector to be calibrated.	
11. If Tc-99m is used, fill the glass vial to a maximum of 2 cm. The surface of the liquid must be below the top of the exposure hole.	
12. Place a Tc-99m or Co-57 point source of approximately 40 MBq or 1.0 mCi in the holder.	
13. Make sure that the entire detector FOV is exposed to the source and that the point source is centered relative to the FOV.	
14. Remove the collimator from the detector to be calibrated.	
Note. The detector undergoing PMT calibration must *not* have a collimator mounted.	
15. Make sure that the entire detector FOV is exposed to the source and that the count rate is < 40 kcps.	
16. When the source is in position, the collimator removed and the count rate is correct, click Start to begin the PMT calibration.	
The calibration goes through several iterations while adjusting the gain of each of the PMT's.	

Procedure	***Details***

The PMT gain values are displayed in colors indicating their status:

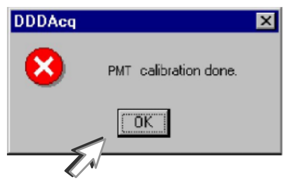
- Yellow indicates that tuning is in progress
- Green indicates that the PMT has been tuned
- Red indicates that the PMT has failed tuning and is outside range.

The range of the PMT gain values is 0 – 1023, typically between 200 and 800.

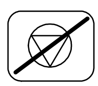


PMT gain values

When the output of all the PMT's is at the same level, the calibration is complete. A message notifies the user that the calibration is complete.



17. Click OK to close the message.
18. Remount the collimator on the detector that has just been calibrated.
19. Press the hand controller Collision Override button to enable power to the motors.



20. Repeat the procedure to PMT tune the other detector, or
21. Click Exit to close the PMT page.

4.2.4 Energy Calibration (ECal)

4.2.4.1 Description

Energy Calibration ensures that the digital representation of the energy spectrum matches window selections and the spectrum display. The calibration is based upon two or three known isotope peaks exposing the detector. Two isotope peaks are used though the calibration procedure supports up to three peaks.

Note. ECal must be preceded by HV and PMT calibration.

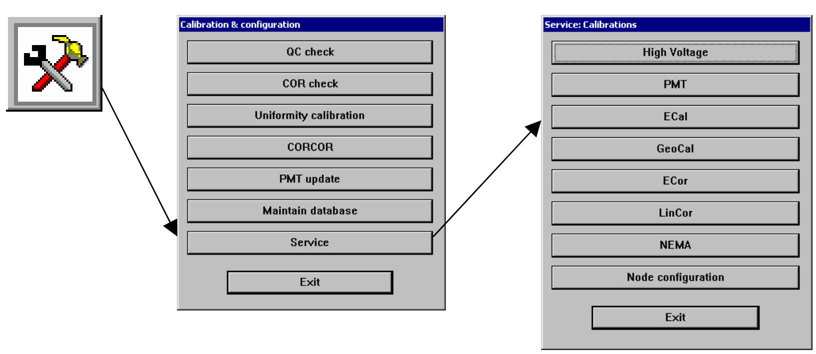
Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed before Energy calibration can be performed. See Chapter 12 *CardioMD AC Option* for instructions.

4.2.4.2 Energy Calibration Procedure

To be performed:	When the EDC board, X-E board or crystal is replaced.
Detector:	One detector at a time, without collimator.
Source:	High Energy: Tc-99m ~ 40 MBq or 1 mCi Low Energy: Low peak of Tl-201, Ga-67, Ba-133 or Am-241 ~ 40 MBq or 1 mCi.
Total calibration time:	Approximately 5 minutes per detector.
Calibration file created:	`C:/Cardiocam/calibrations/ecal.det1` and `det2` respectively.

Procedure	***Details***

1. Remove the collimator from the detector to be calibrated. See the Operator's Manual for instructions.
2. Ensure that the CardioMD system is in the patient load position.
3. On the Persistence page, click the Tools button.
4. When the Calibration & Configuration menu appears, click Service.
5. If prompted, enter the service password (see page 4-9 for instructions).
6. In the Service Calibrations menu, click ECal.



Procedure	***Details***

7. In the Counts field, enter 3000000 (3 million).
8. Set Width to 30.
9. In the Window 1 field, enter 140.5 for Tc-99m.
10. Depending on the isotope being used, fill in the Window 2 field as follows:
    For Tl-201: 68
    For Ba-133: 81
    For Ga-67: 92
    For Am-241: 59.
11. Leave the Window 3 field blank.
12. Select the detector to be calibrated.

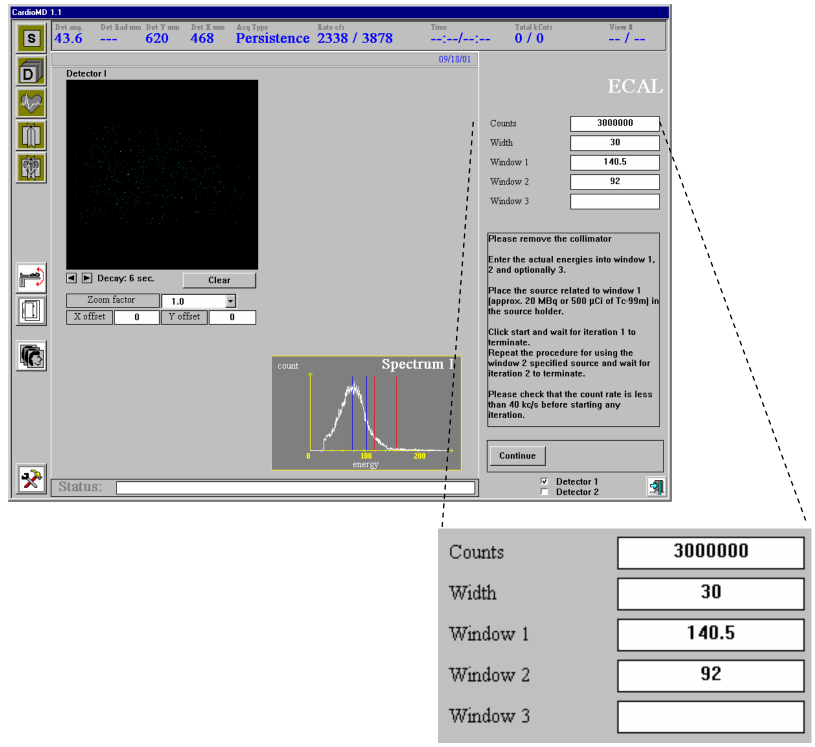
Note. This calibration runs in up to three different passes, depending on whether you enter two (minimum) or three window values.

Note. It is possible to use Tc-99m and a different isotope but you must remember to switch sources *before* clicking OK after the first pass.

13. Click Continue.
14. Press and hold the hand controller Collision Override button for a minimum of 4 seconds before proceeding as follows:
15. While still pressing Collision Override, click OK to accept automated motions bringing the system into position for calibration of the selected detector.

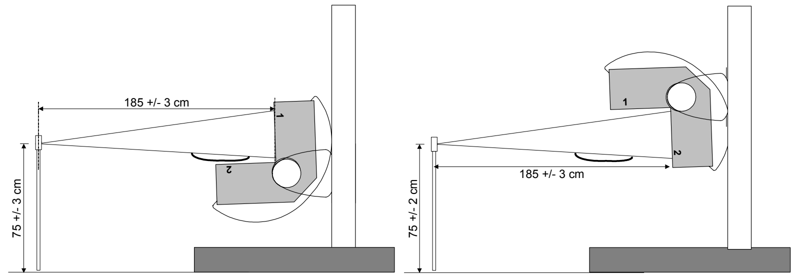
Note. The hand controller Collision Override button must be kept depressed during all automated motions to enable power to the motors.

Note. Automated motions must be started from the patient load position.



Procedure	***Details***

16. Place the point source holder at a minimum distance of approximately 1.85 meters (6 ft.) from the detector to be calibrated.
17. Place a Tc-99m point source of approximately 40 MBq or 1 mCi in the holder.
18. Make sure that the entire detector FOV is exposed to the source and that the count rate is < 40 kcps.



Note. The detector to be calibrated must *not* have a collimator mounted.

19. Click Start to acquire the window 1 spectrum.

When the message box with the text Iteration 1 appears:

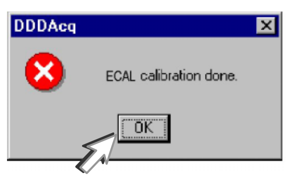
Note. Do *not* click OK until the source has been replaced.

20. Remove the Tc-99m source and place the other source (Tl-201, Ga-67, Ba-133 or Am-241) in the source holder.
21. Now click OK.

When the message box with the text Iteration 2 appears:

22. Click OK to acquire the window 3 spectrum (if the field Window 3 was not left blank).

When all energy spectra have been acquired, the procedure is completed and this message appears.



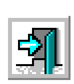
23. Click OK to close the message.

Typical energy coefficients are:

- Parameter C0: – 0 +/– 20
- Parameter C1: – 1 +/– 0.3
- Parameter C2: – 0 +/– 0.002

Note. These values apply, regardless of the isotope used.

24. Repeat the procedure to calibrate the other detector, or
25. Click Exit to close the ECal page.



4.2.5 Geometry Calibration (GeoCal)

4.2.5.1 Description

Geometry calibration adjusts the image geometry for symmetry and uniform spatial registration over the energy range.

Four multiple energy point sources are placed on the outer calibration marks on the crystal surface and two images of the point sources are acquired in a dual energy setup. The position of the images of the point sources is calculated for both of the two energies. Based on the result, the normalization table is modified to correct for any mismatch. With this normalization table applied, another iteration of acquisition and calculation is run to check the result. The process is repeated (typically 5 to 10 times) until the specification is met.

Note. If the CardioMD AC system is equipped with the AC option, the transmission scanners must be removed before a GeoCal calibration can be performed.

Note. GeoCal must be preceded by HV, PMT and ECal calibration. When GeoCal has been completed, a PMT update must be performed.

Note. If GeoCal is required on one detector following high voltage calibration, perform a GeoCal on the other detector, as well.

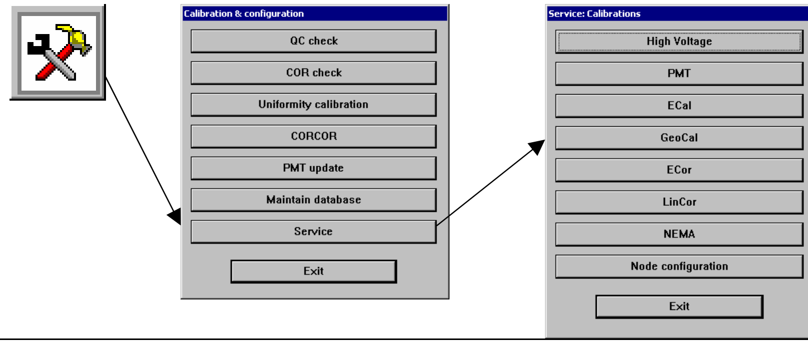
4.2.5.2 Geometry Calibration Procedure

To be performed:	When the EDC board, X-E board, Y board or crystal is replaced.
Detector:	One detector at a time with GeoCal mask (part of service calibration kit).
Source:	4 sources, Ba-133, Ga-67 or Tl-201 of ~ 4 – 12 MBq or 0.1 – 0.3 mCi each.
Source holders:	4 pcs. with 4 bottles (part of service calibration kit).
Total calibration time:	Approximately 10 minutes per detector.
Calibration file created:	`C:/Cardiocam/calibrations/geocal.det1` and `det2` respectively.

Procedure	***Details***
1. Remove the collimators from the detector to be calibrated. See the Operator's Manual for instructions.	
2. Ensure that the CardioMD system is in the patient load position.	

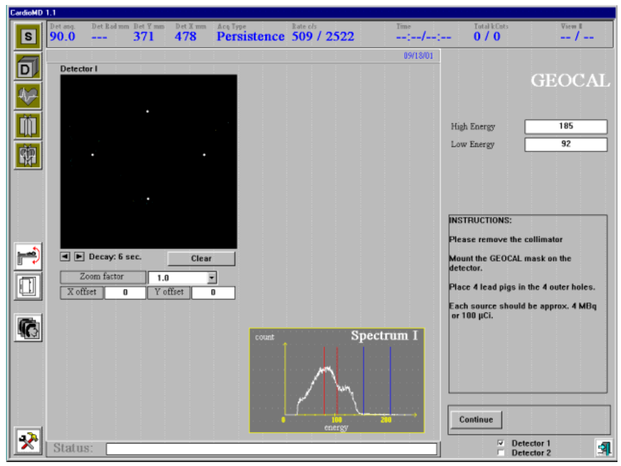
Procedure	*Details*

3. On the Persistence page, click the Tools button.
4. When the Calibration & Configuration menu appears, click Service.
5. If prompted, enter the service password (see page 4-9 for instructions).
6. In the Service Calibrations menu, click GeoCal.



On the GeoCal page:

7. Depending on the isotope being used, fill in the High Energy field as follows:
   Ba-133: 155
   Tl-201: 167
   Ga-67: 185.
8. Fill in the Low Energy field as follows:
   Ba-133: 81
   Tl-201: 75
   Ga-67: 92.
9. Select the detector to be calibrated.



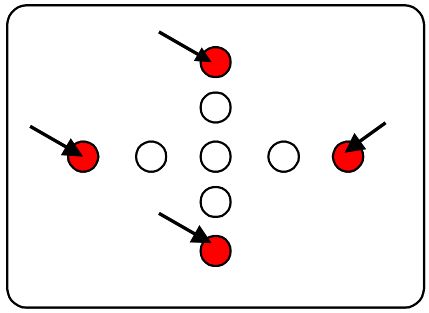
10. Click Continue.
11. Press and hold the hand controller Collision Override button for a minimum of 4 seconds before proceeding as follows:
12. While still pressing Collision Override, click OK to accept automated motions bringing the system into position for calibration of the selected detector.

Note. The hand controller Collision Override button must be kept depressed during all automated motions to enable power to the motors.

Note. Automated motions must be started from the patient load position.

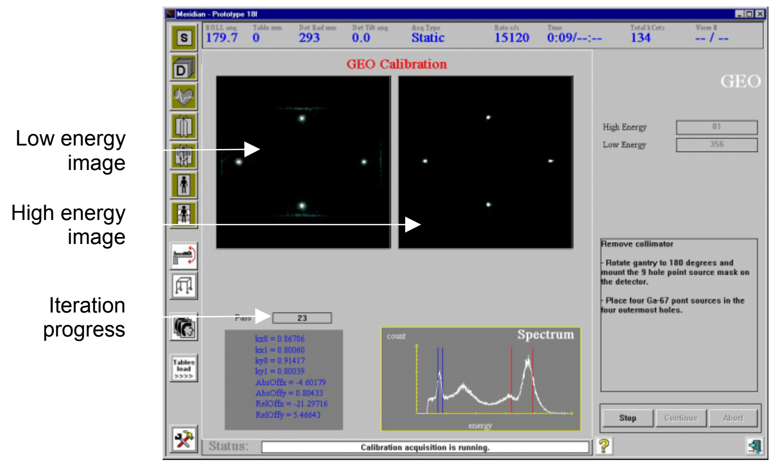
Procedure	***Details***

13. Mount the GeoCal mask on the detector to be calibrated. Place the 4 lead pigs in the 4 outer holes in the mask.



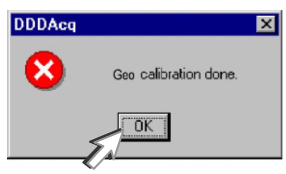
14. Click Start.

During calibration, the GeoCal acquisition page looks similar to the example on the right.



When the geometry calibration is completed, the message shown to the right appears.

15. Click OK to close the message box.



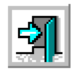
Typical GEOCal results are:

- Parameter KX0: 1 +/– 0.2
- Parameter KX1: 0 +/– 0.01
- Parameter KY0: 1 +/– 0.2
- Parameter KY1: 0 +/– 0.01
- Parameter ABSOFFX: 0 +/– 1
- Parameter ABSOFFY: 0 +/– 1
- Parameter RELOFFX: 0 +/– 1
- Parameter RELOFFX: 0 +/– 1

Note. These typical results apply regardless of the isotope used.

Note. After GeoCal, a PMT update is required because the size of the flood image has been altered.

16. Repeat the procedure to calibrate the other detector, or

Procedure	***Details***
17. Click Exit to close the GeoCal page.	

4.2.6 Energy Correction Calibration (ECor)

4.2.6.1 Description

Energy correction is a spatially related energy correction map. The map is generated based on relative count rate information in two energy windows, one on each side of the chosen isotope peak. The map generation is an iterative process typically consisting of 3-5 iterations.

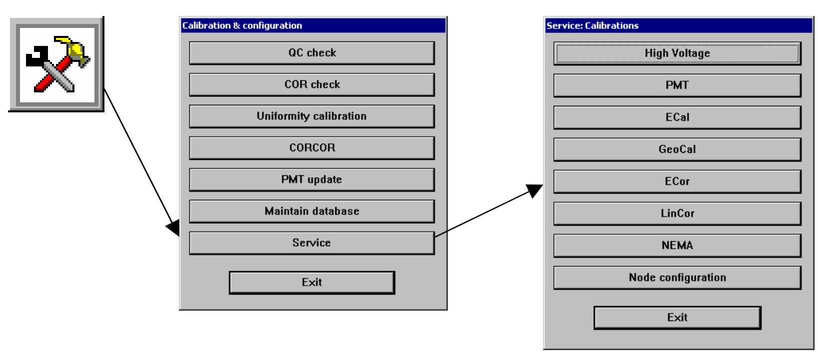
Once generated, each address in the map will contain a correction factor that is applied to the energy signal during acquisitions.

Note. ECor must be preceded by HV, PMT, ECal and GeoCal calibration.

Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed before Energy correction calibration can be performed. See Chapter 12 *CardioMD AC Option* for instructions.

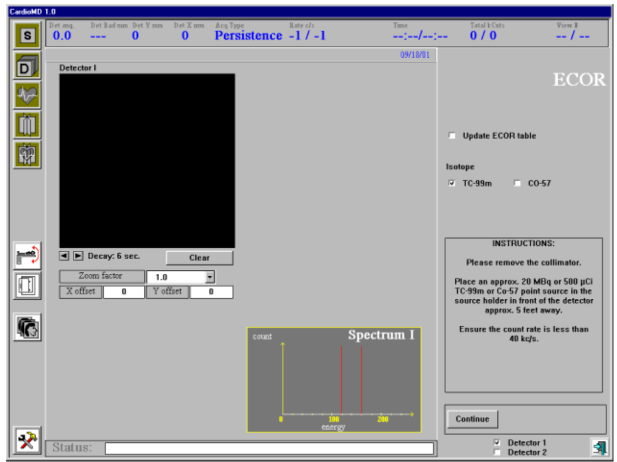
4.2.6.2 Energy Correction Procedure

To be performed:	When the EDC board, PMT tube, X-E board, Y board or crystal is replaced.
Detector:	One detector at a time, intrinsic.
Source:	Tc-99m or Co-57 ~ 40 MBq or 1 mCi in the source holder.
Total calibration time:	Approximately 30 minutes per detector.
Calibration file created:	`C:/Cardiocam/calibrations/ecor.det1` and `det2` respectively.

Procedure	***Details***
1. Remove the collimator from the detector to be calibrated. See the Operator's Manual for instructions.	
2. Ensure that the CardioMD system is in the patient load position.	
3. On the Persistence page, click the Tools button.	
4. When the Calibration & Configuration menu appears, click Service.	
5. If prompted, enter the service password (see page 4-9 for instructions).	
6. In the Service Calibrations menu, click ECor.	

Procedure	***Details***

The ECor page appears.



7. Unless a major repair requires a calibration from scratch, select Update ECOR table.
8. Select the appropriate isotope (either Tc-99m or Co-57).
9. Select detector 1 or 2 to be calibrated.

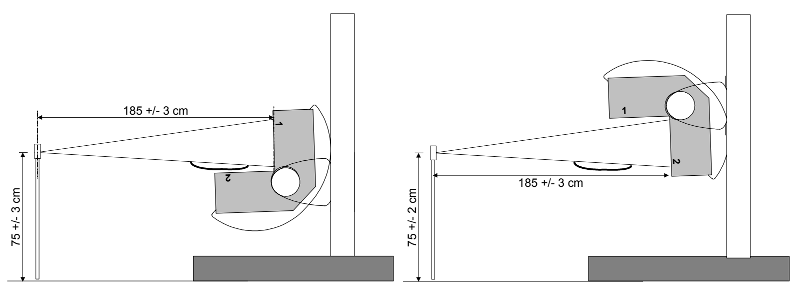
Note. If updating ECor, either isotope can be selected. The update is not dependent upon the isotope used during the initial ECor calibrations.

10. Click Continue.
11. Press and hold the hand controller Collision Override button for a minimum of 4 seconds before proceeding as follows:
12. While still pressing Collision Override, click OK to accept automated motions bringing the system into position for calibration of the selected detector.

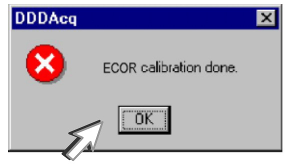
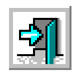
Note. The hand controller Collision Override button must be kept depressed during all automated motions to enable power to the motors.

Note. Automated motions must be started from the patient load position.

13. Place the point source holder at a distance of approximately 1.85 meters (6 ft.) from the detector to be calibrated.



14. Place a Tc-99m or Co-57 point source of approximately 40 MBq or 1 mCi in the holder.
15. Make sure that the entire detector FOV is exposed to the source and that the count rate is < 40 kcps.
16. When the source is in position, click Start to begin the calibration.

Procedure	***Details***
When the ECor calibration is complete, this message appears. 17. Click OK to close the message box.	
18. Repeat the procedure to calibrate the other detector, or	
19. Click Exit to close the ECor page.	

4.2.7 Spatial Linearity Correction Calibration (LinCor)

4.2.7.1 Description

Linearity correction is a spatially related linearity correction. The map is generated based on images of phantoms with slit patterns, one for the X direction and one for the Y direction. From those images, deviations from an "ideal" slit pattern are calculated and a map with correction factors is generated. Once generated, each address in the map will contain a correction factor that is applied to the position signals during acquisition.

Note. LinCor must be preceded by HV, PMT, ECal, GeoCal and ECor calibration.

Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed before spatial linearity correction calibration can be performed. See Chapter 12 *CardioMD AC Option* for instructions.

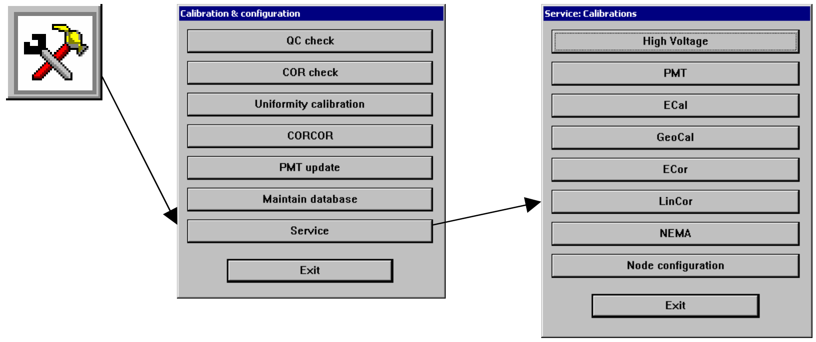
4.2.7.2 Spatial Linearity Correction Calibration Procedure

To be performed:	When the EDC board, a PMT tube, X-E board, Y board or crystal is replaced.
Detector:	One detector at a time, X and Y spatial masks (part of service calibration kit).
Source:	Tc-99m or Co-57 ~ 120 – 200 MBq or 3-5 mCi.
Total calibration time:	Approximately 90 minutes per detector.
Calibration file created:	`C:/Cardiocam/calibrations/lincor.det1` and `det2` respectively.

Procedure	***Details***
1. Remove the collimators from the detector to be calibrated. See the Operator's Manual for instructions.	
2. Ensure that the CardioMD system is in the patient load position.	

Procedure	*Details*

3. On the Persistence page, click the Tools button.
4. When the Calibration & Configuration menu appears, click Service.
5. If prompted, enter the service password (see page 4-9 for instructions).
6. In the Service Calibrations menu, click LinCor.



The LinCor page appears.

7. In the Counts field, enter 60000000 (60 million).
8. Set Width to 30.
9. Select the appropriate isotope.
10. Select the detector to be calibrated.

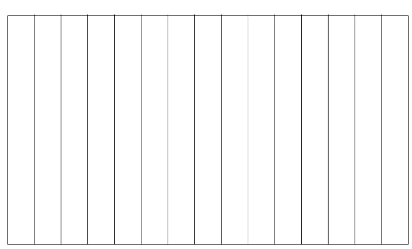
11. Click Continue.
12. Press and hold the hand controller Collision Override button for a minimum of 4 seconds before proceeding as follows:
13. While still pressing Collision Override, click OK to accept automated motions bringing the system into position for calibration of the selected detector.

Note. The hand controller Collision Override button must be kept depressed during all automated motions to enable power to the motors.

Note. Automated motions must be started from the patient load position.

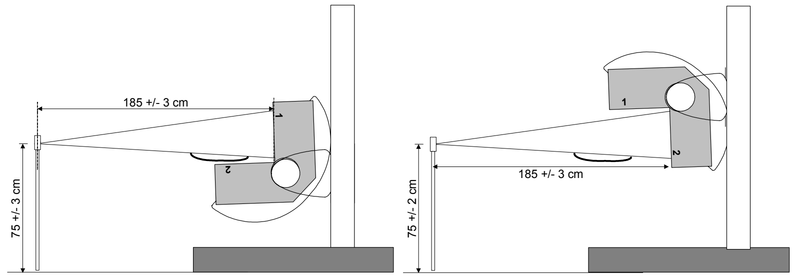
14. Place the X-linearity phantom on the detector.

Note. The X-linearity phantom has slits along its short axis.


X-linearity phantom

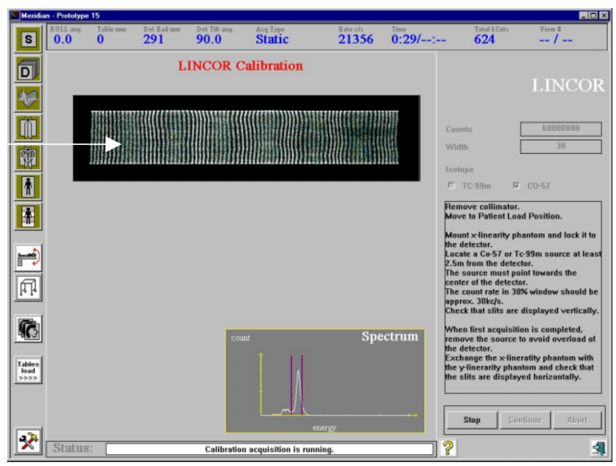
Procedure	***Details***

15. Place the point source holder at a minimum distance of approximately 1.85 meters (6 ft.) from the detector to be calibrated.
16. Place a Tc-99m or Co-57 point source of approximately 160 – 200 MBq or 4 – 5 mCi in the holder.
17. Ensure that the source is placed precisely in front of the center of the detector FOV.
18. Verify that the count rate is < 40 kcps and that slits are displayed vertically in the image window.
19. Click Start.



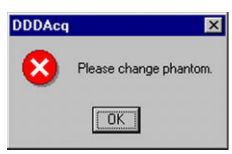
After a few million counts, check that all the slits in the phantom are clearly resolved. The purpose is to make sure that a defective table is not causing neighbor tubes to "pull" counts and distort linearity.

Slits



When the calibration in the X-direction is done, this message pops up.

Note. Do *not* click OK at this point.

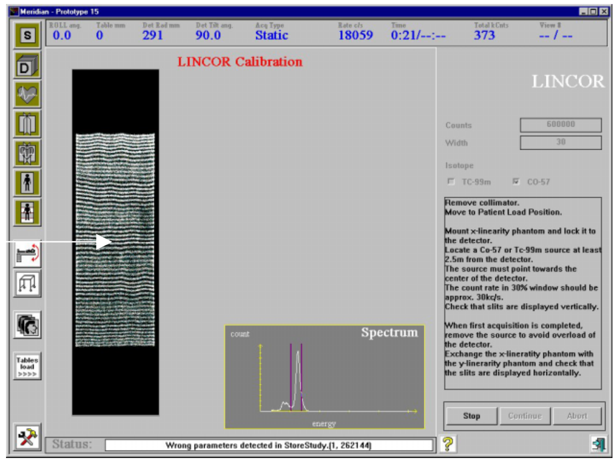
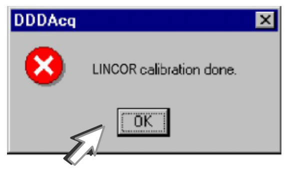


20. Remove the point source.

Note. The source must be removed to avoid saturating the open detector.

21. Swap phantom from X to Y.
22. Put the source back in place.
23. Click OK in the message box.

Y-linearity phantom

Procedure	***Details***
The system proceeds to acquire Y linearity data. 24. After a few million counts, check that all slits in the phantom are clearly resolved.	
When the detector has been calibrated in both the X and Y direction, this message pops up. 25. Remove the source to avoid saturating the open detector. 26. Click OK. 27. Repeat the procedure to calibrate the other detector, or	
28. Click Exit to close the LinCor page.	

4.2.8 Uniformity Calibration (UnifCor)

4.2.8.1 Description

The uniformity of the scintillation crystal in the detector depends on the energy of the isotope used, and the collimators may have minor variations in sensitivity. To compensate for non-uniformity, CardioMD requires uniformity calibration.

The flexible scheme of uniformity correction supported by CardioMD enables the user to acquire both intrinsic and extrinsic uniformity correction tables. Uniformity correction tables can be acquired at any isotope peak (or combinations with multiple peaks) and with specific energy windows to match the setup for clinical applications exactly.

4.2.8.2 Uniformity Calibration Procedure

To be performed:	When the detector has been re-calibrated or when intrinsic uniformity is out of spec (2.5 % integral and 1.5 % differential).
Detector:	One detector at the time, intrinsic or extrinsic. **Note**. FOV mask is used for intrinsic calibrations
Source:	Specific isotope ~ 40 MBq or 1 mCi (intrinsic), ~ 120 – 200 MBq or 3 – 5 mCi (extrinsic).
Total calibration time:	Approximately 20 minutes per detector.

Calibration file created:	Intrinsic: `C:/Cardiocam/calibrations/Uniformity Maps/U.None.<keV>.1` (or `.2`) Extrinsic: `C:/Cardiocam/calibrations/Collimator Maps/U.LEHR` (or `LEGP`)`.<keV>.1` (or `.2`)

Intrinsic Uniformity Calibration Procedure

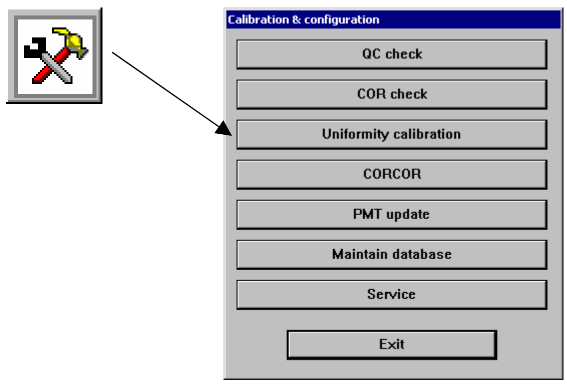
Note. If the CardioMD system is equipped with the AC Option, the special AC option point source holder must be used for the intrinsic uniformity calibration. See Chapter 12 *CardioMD AC Option* for instructions.

Procedure	***Details***

1. Ensure that the CardioMD system is in the patient load position and that the acquisition PC is displaying the Persistence page.
2. Click the Tools button.

The Calibration & Configuration menu appears.

3. In the Calibration & Configuration menu, click Uniformity calibration.

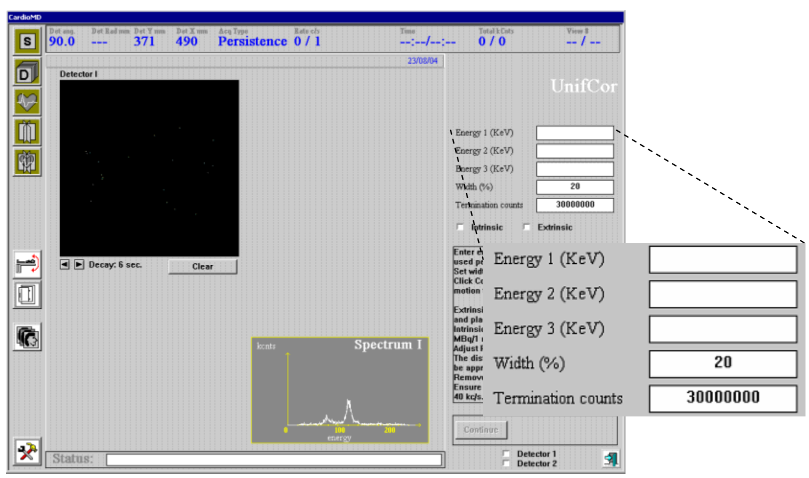


The Uniformity Calibration page appears.

4. Specify the energy settings for the uniformity correction table to be acquired.
5. Select Intrinsic.
6. Select the detector to be calibrated.

The uniformity correction table is assigned a filename of the form:
`U.coll.ew1.ew2.ew3.detectorNum`

Where:
`coll` is set to `LEGP`, `LEHR` or `NONE`, depending on the collimator mounted on the detector.
`Ew1`, `ew2`, `ew3` are set to the values entered for the isotope peaks.
`DetectorNum` is set to either `1` or `2`, depending on which of the detectors the table is acquired for.



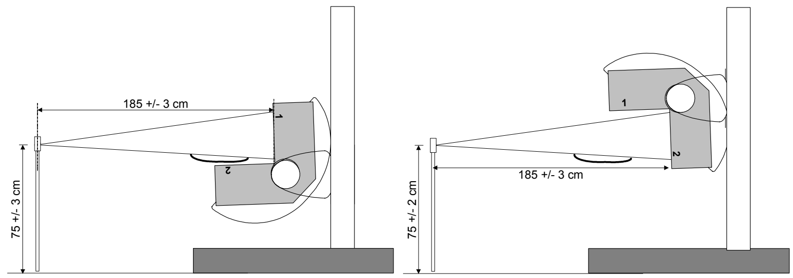
Procedure	***Details***

7. Click Continue.

8. When prompted, click OK to accept automated motions.

The detectors are automatically positioned for intrinsic uniformity calibration of the selected detector.

9. Place the point source in the source holder and position the source holder at a distance of approximately 1.85 m (6ft.) from the surface of the detector.



Note. If the CardioMD AC option is mounted on the system, the special AC option point source holder must be used. See Chapter 12 *CardioMD AC Option* for details.

10. Ensure that the point source is centered relative to the detector field of view.

    Check the position of the activity in the image window on the acquisition PC. By pressing [F9], you activate the center cross hair in the image window. You may find this useful for positioning the source holder.

11. Remove the collimator from the selected detector and mount the FOV mask instead.

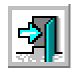
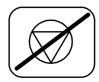
12. Loosen and slide out the collimator on the other detector a little.

Note. It is necessary to loosen the collimator on the other detector in order for the CardioMD system to detect the collimator type NONE.

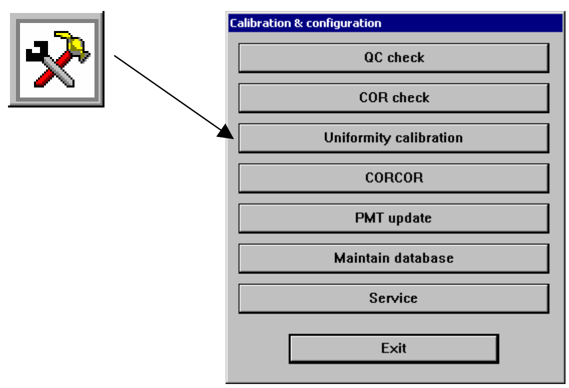
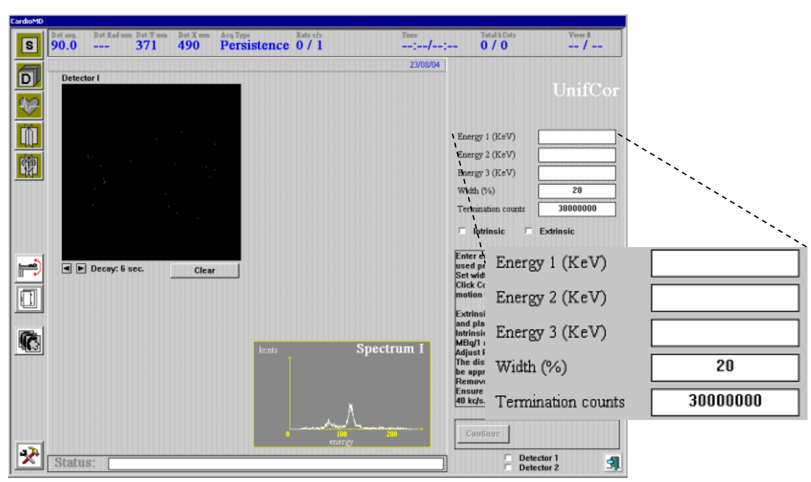
13. Verify that the count rate is less than 40 kc/s.

14. Click Start to start the uniformity calibration of the selected detector.

When the calibration is complete, the table is automatically stored.

Procedure	*Details*
15. Click Exit to close the Uniformity Calibration page.	
16. Replace the FOV mask with the collimator.	
17. Slide the collimator on the other detector back in place.	
18. Press the hand controller Collision Override button and wait for a minimum of 4 seconds.	
19. Repeat the procedure outlined above to calibrate the other detector.	
20. Click Exit to close the Uniformity Calibration page.	

Extrinsic Uniformity Calibration Procedure

Procedure	*Details*
1. Ensure that the CardioMD system is in the patient load position and that the acquisition PC is displaying the Persistence page.	
2. Click the Tools button. The Calibration & Configuration menu appears. 3. In the Calibration & Configuration menu, click Uniformity calibration.	
The Uniformity Calibration page appears. 4. Specify the energy settings for the uniformity correction table to be acquired. 5. Select Extrinsic. 6. Select the detector to be calibrated. The uniformity correction table is assigned a filename of the form: `U.coll.ew1.ew2.ew3.detectorNum` Where: `coll` is set to `LEGP`, `LEHR` or `NONE`, depending on the collimator mounted on the detector.	

Procedure	***Details***

`Ew1`, `ew2`, `ew3` are set to the values entered for the isotope peaks.

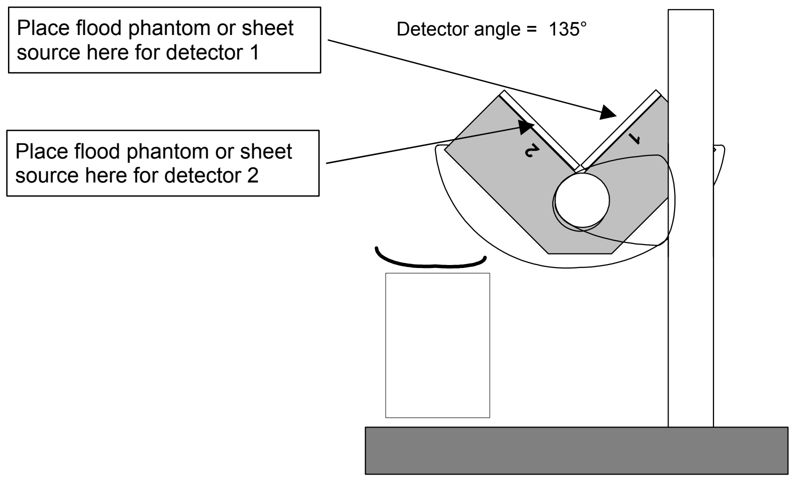
`DetectorNum` is set to either `1` or `2`, depending on which of the detectors the table is acquired for.

7. Click Continue.

8. When prompted, click OK to accept automated motions.

The detectors are automatically positioned for extrinsic uniformity calibration of the selected detector.

9. Place a sheet source or a flood phantom filled with the appropriate isotope and uniformly mixed on the surface of the collimator on the detector.
10. Verify that the count rate is less than 40 kc/s.



Note. When the CardioMD AC option is mounted on the system, it is not possible to use this calibration position. See Chapter 7 *CardioMD AC Option* of the CardioMD Operator's Manual for further information.

11. Click Start to start the uniformity calibration.

When the calibration is completed, the table is automatically stored.

12. Click Exit to close the Uniformity Calibration page.

13. Repeat this procedure to calibrate the other detector.

4.2.9 Center of Rotation (COR) Calibration

4.2.9.1 Description

A center of rotation correction is used when reconstructing tomographic data to correct for minor misalignment between the center of the image and the axis of rotation. Center of rotation (COR) corrections are stored in a correction table and will be applied automatically after a data set has been acquired.

COR correction is collimator specific. It is necessary to acquire a COR correction for each set of collimators used for tomographic scans.

4.2.9.2 Center of Rotation Calibration Procedure

To be performed:	When the EDC board, a PMT tube, X-E strip, Y strip or crystal is replaced.	
Detector:	Extrinsic (should be performed for each set of collimators used for SPECT acquisition).	
Source:	Specific isotope	
	LEHR collimator	40–120 MBq or 1–3 mCi point source
	LEGP collimator	40–120 MBq or 1–3 mCi point source
Total calibration time:	Approximately 20 minutes	
Calibration file created:	`C:/Cardiocam/calibrations/CORcor/CORcor.coll-X` where X represents the assigned collimator number: 0 = LEGP 1 = LEHR.	

Note. Before the COR acquisition is started, the system identifies the type of the collimator mounted on the detector. This enables the system to store the acquired COR corrections for a specific collimator under the matching file name.

Note. If a correction table for the type of collimators already exists, the system automatically overwrites the old table immediately after the new correction table has been acquired.

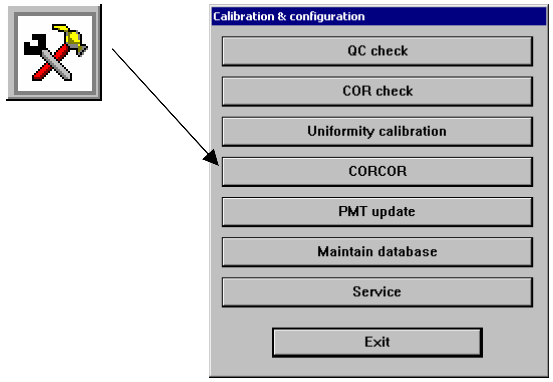
Procedure	*Details*
1. Verify that the collimators, for which the COR correction is to be acquired, are mounted on the detectors.	
2. Ensure that the CardioMD system is in the patient load position.	

Procedure	***Details***

3. On the acquisition PC's Persistence page, click the Tools button.

The Calibration & Configuration menu appears.

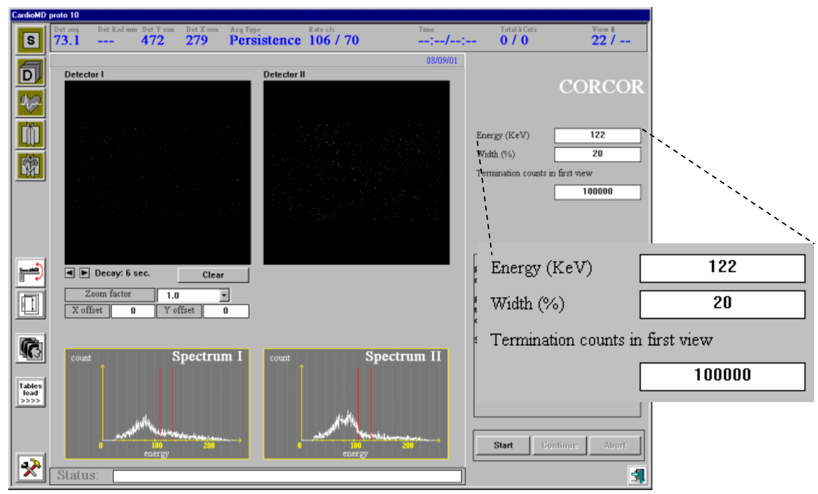
4. In the Calibration & Configuration menu, click CORCOR.



The CORCOR page appears displaying default settings for Energy, Window Width and Termination counts in first view.

5. If the settings are acceptable, continue the procedure.
   If the settings are to be changed, enter the new energy value for the appropriate isotope.

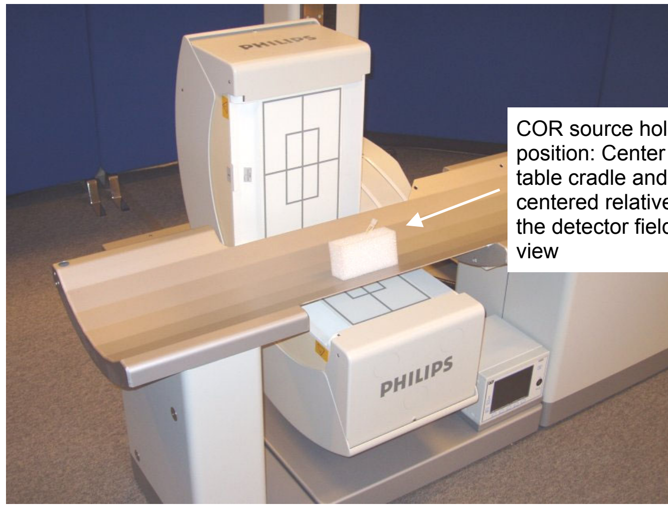
For example, keep the 20% window width but set Termination counts in first view to 25000 (25 kc). The default is 100 kc but 25 kc is sufficient and less time consuming.



6. Use a Co57 point source or fill the vial with Tc-99m.

If the vial is used, it must be filled with between 0.2 and 0.3 milliliters. Use a syringe to fill the vial cautiously so that no activity ends up on the walls of the vial. Seal the vial with the lid. The point source should be 40–120 MBq or 1–3 mCi.

7. Place the point source in the COR source holder supplied with the system.

Procedure	***Details***
8. Position the COR point source holder with the source at the middle of the table cradle and center it relative to the detectors field of view. To keep the source in place during the acquisition, you can use a piece of adhesive tape to secure the source to the table cradle. 9. Verify that that the count rate is approximately 5 – 10 kc/s.	 **Note**. The appearance of your system may be slightly different from the system shown in this photograph. However, there is no difference in the usage of the COR point source holder
10. Click Start to start the COR acquisition. 11. When prompted, click OK to accept automated motions The system rotates 180° in 256 steps. After the acquisition, the system automatically stores the acquired COR corrections for the specific collimator under the matching file name. **Note**. If a correction table for the type of collimators already exists, the system automatically overwrites the old table immediately after the new correction table has been acquired.	
12. When the acquisition has been completed successfully, click Exit to close the COR-COR page.	
To verify the validity of the COR calibration: 13. Perform a COR check. See instructions in the CardioMD's Operator's Manual.	

4.3 Detector Performance Tests

The verification procedures described in this section are to be performed in the field during installation, when directed by another procedure, or as part of normal maintenance.

4.3.1 Center of Rotation (COR) Analysis

4.3.1.1 Description

COR analysis is performed to test the center of rotation registration of the detector. A center of rotation correction is used when reconstructing tomographic data to correct for minor misalignment between the center of the image and the axis of rotation. Center of rotation (COR) corrections are stored in a correction table and are applied as the data set is being acquired.

A COR correction is specific to a collimator. Therefore COR analysis should be performed for each set of collimators.

Note. It is necessary to acquire a COR correction for each collimator that is used for tomographic scans.

4.3.1.2 Center of Rotation Analysis Procedure

To be performed:	After acquiring a COR correction.	
Detector:	Extrinsic (should be performed for each set of collimators used for SPECT acquisition).	
Source:	Specific isotope	
	LEHR collimator	~ 40 MBq or 1mCi point source
	LEGP collimator	~ 40 MBq or 1mCi point source
Total calibration time:	Approximately 15 minutes.	

See the procedure in Chapter 5 *Maintenance* of the CardioMD Operator's Manual.

4.3.2 Flood Uniformity Test

4.3.2.1 Description

The flood uniformity test ensures that the uniformity of the camera field is sufficient to prevent the introduction of artifacts into clinical studies. The test is performed intrinsically or extrinsically, using either Tc-99m or Co-57. You must ensure that appropriate uniformity correction can be applied. The most accurate check is performed intrinsically with an intrinsically acquired uniformity correction table applied.

After acquisition of the QC check image, a uniformity calculation is performed to present uniformity figures as well as images for visual inspection.

4.3.2.2 Flood Uniformity Check Procedure

See the procedure in Chapter 5 *Maintenance* of the CardioMD Operator's Manual.

4.4 Motion Calibration

4.4.1 Introduction

CardioMD has four independent axes of motion. These are:

- Detector rotate
- Detector Y (vertical)
- Detector X (horizontal)
- Table longitudinal.

The table axis needs no calibration. One micro switch is used to detect center position. The state of this micro switch is read by the rotate (master) motion controller and used for automatically centering of the table as part of patient load positioning.

The other three axes are servo loop controlled by the motion controllers. The position feedback for these servo loops to the motion controllers comes from high-resolution incremental encoders. As the encoders are incremental, each of the three axes has an additional absolute encoder mounted. The absolute encoders – which have less resolution than the incremental encoders – are used to determine the positions of the axes at power up. That is, when power is applied to the system, the motion controllers read the absolute position of each axis and use it to index the incremental encoders.

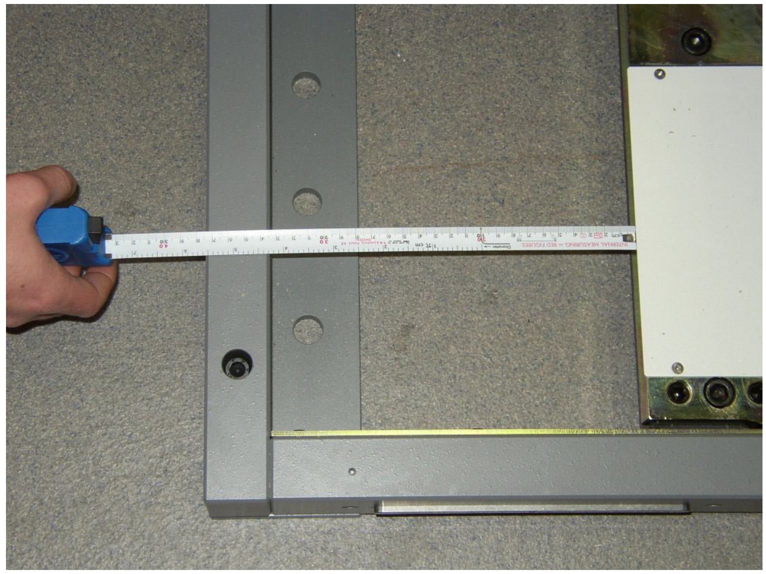
The three absolute encoders require calibration after having been replaced or dismounted, or following replacement of any of the vital components in the drive (such as the gear). The procedure below describes how to calibrate all three encoders simultaneously. However, each encoder may be calibrated separately.

4.4.2 Calibration of Absolute Encoders

Procedure	***Details***
First, the system must be placed in the correct position for calibrating the encoders:	
1. Ensure that collimators are mounted on both detectors.	
2. Use the hand controller to move the detectors beneath the table and rotate the detectors to + 90° (detector 1 in vertical position and detector 2 in horizontal position).	
3. Use a level to verify that the rotate angle of detector 1 is 90° and the rotation angle of detector 2 is 0°, relative to horizontal.	
4. Remove the gantry base cover.	
Note. Detailed instructions for removing the gantry base cover on CardioMD Series III systems are provided in Chapter 6 *Repair Procedures*.	III

Procedure	***Details***

5. Use the hand controller to move the detectors in the X direction until the distance between the front edge of the moveable gantry horizontal base and the back edge of the front gantry frame is exactly 234 mm (9.2”).



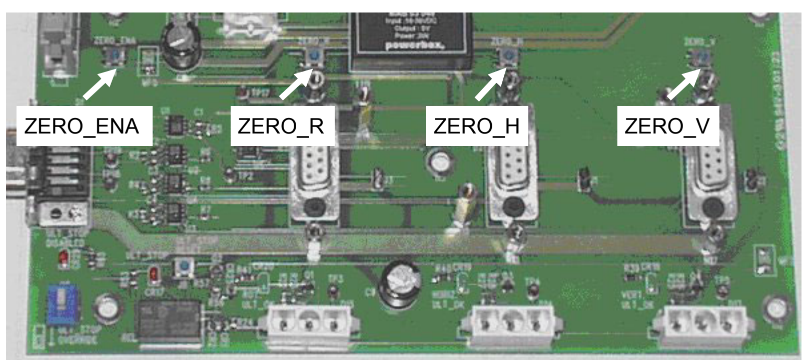
To reach the Y calibration position:

6. Move the detectors vertically until the distance between the top surface of the detector rotate arm and the top edge of the vertical direction opening is exactly 790 mm (31 3/32”).

See the photo on the right.

Now, proceed to perform the calibration:

7. On the safety board, press ZERO_ENA and ZERO_R simultaneously to calibrate the rotate absolute encoder.
8. On the safety board, press ZERO_ENA and ZERO_V simultaneously to calibrate the vertical absolute encoder.
9. On the safety board, press ZERO_ENA and ZERO_H simultaneously to calibrate the horizontal absolute encoder.
10. Reset both motion controllers by setting switch 10 in ON position (upwards) on



Procedure	***Details***
both motion controllers.	
11. Remove the reset on the rotate controller (master) by setting switch 10 in OFF position (downwards) again.	
12. Remove the reset on the linear (slave) motion controller by setting switch 10 in OFF position (downwards) again.	
13. On the acquisition PC, close down the CardioMD application.	
14. Wait approximately 5 seconds before restarting the application.	
15. Use the hand controller Collision Override button and the X and Y motion buttons to move both X and Y motion back within software limits.	

WARNING

Always double-check the position of switch 8 on *both* motion controllers after any service involving the controllers.

WARNING

Always perform a COR check following calibration of any of the absolute encoders to check if a new COR calibration is required.

4.4.3 Calibration of Y Ultimate End Stop

No adjustment required.

4.4.4 Calibration of Rotation Ultimate End Stop

No adjustment required.

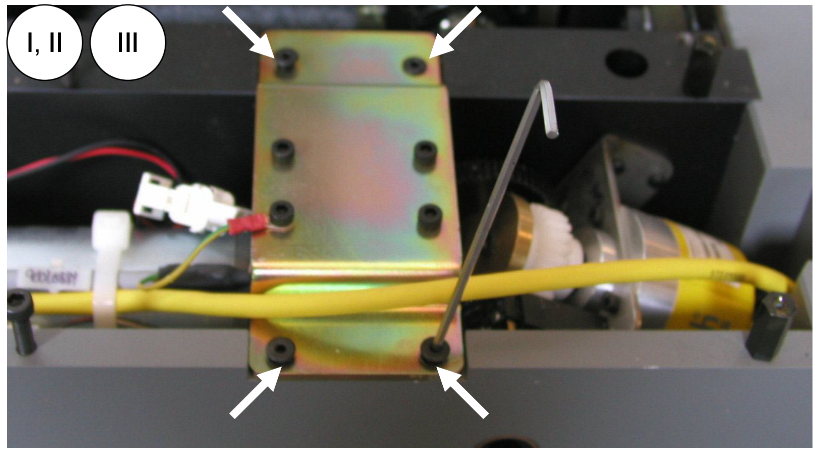
4.4.5 Calibration of X Ultimate End Stop

Procedure	***Details***
1. Use the hand controller to move the detectors as far upwards as they will go.	
2. Cut power to the motors by pressing E-Stop.	
3. Remove the X-drive cover and loosen the gantry base cover.	
Note. Detailed instructions for removing the gantry base cover on CardioMD Series III systems are provided in Chapter 6 *Repair Procedures*.	III

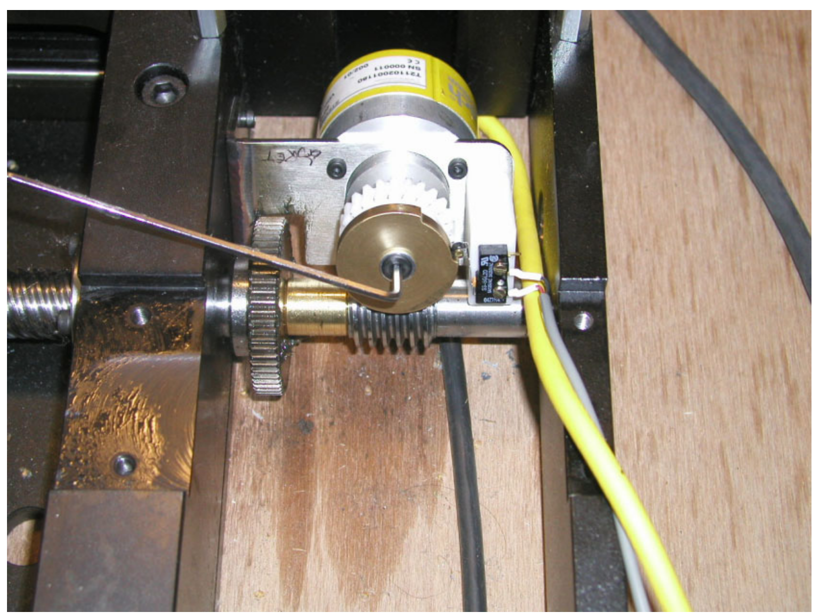
Procedure	***Details***

For an overview of CardioMD covers, see Chapter 2 *System Overview*.

4. Loosen the 4 screws shown holding the X drive motor.
5. Lift the motor to disengage the drive gear.

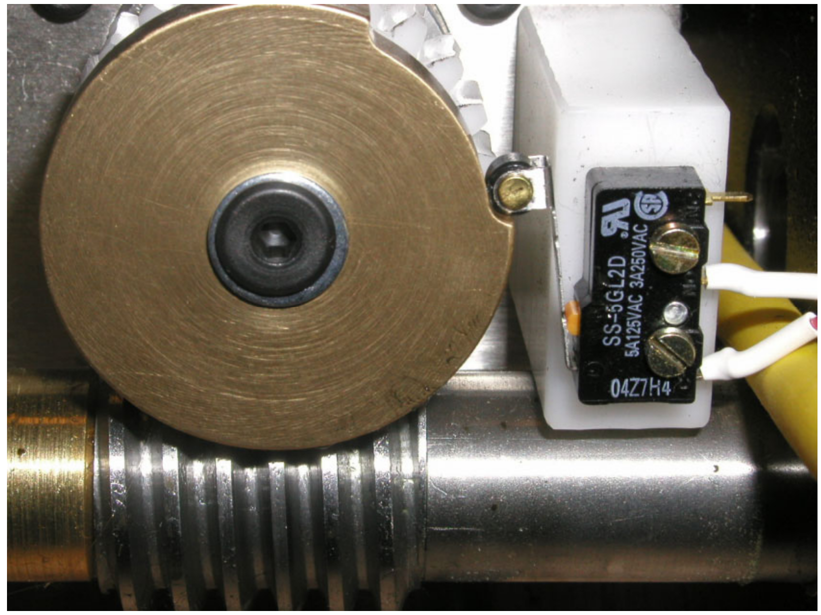


6. Manually move the pillar as far towards the front of the system as it will go until the mechanical end stop is reached.
7. Move the pillar towards the rear of the gantry approximately 3 – 4 mm.
8. Use an Allen key to loosen the ultimate end stop code wheel.

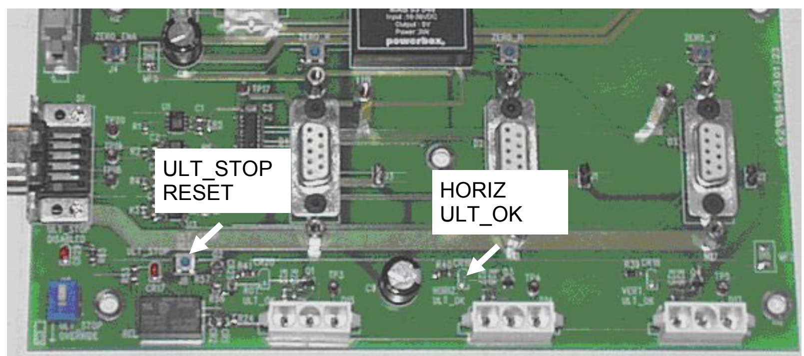


Procedure	***Details***

9. Turn the code wheel until the position of the arm of the micro switch is as shown in the picture – disengaged, but very close to becoming engaged (pressed) if the code wheel is turned further CCW.
10. Fasten the code wheel with the Allen key.



11. Manually drive the pillar/detector backwards until the micro switch is engaged.
12. Check that the ultimate end-stop is not activated (observe the green HORIZ ULT_OK LED indicator on the safety board – the red ULT_STOP LED will still be lit).'
13. Reset the ULT_STOP relay by pressing the ULT_STOP RESET button on the safety board.



14. Check that the red ULT_STOP LED is not lit.
15. Reinstall the X drive motor and the covers.
16. Release the E-Stop.
17. Reset both motion controllers by setting switch 10 in the ON position (upwards) on both motion controllers.
18. Remove reset on the rotate controller (master) by setting switch 10 in the OFF position (downwards) again.
19. Remove reset on the linear (slave) motion controller by setting switch 10 in the OFF position (downwards) again.

Procedure	***Details***
20. On the acquisition PC, close down the CardioMD application.	
21. Wait approximately 5 seconds before re-starting the application.	

4.5 Motion Limit Checks

4.5.1 Introduction

If – for some reason – there is doubt whether the motion system is correctly calibrated, it is recommended that you follow the procedures described in this section before starting to recalibrate the system.

4.5.2 Verifying Absolute Encoder Calibration

Procedure	***Details***
1. Move the detector to the patient load position (horizontal 489 +/– 1 mm, vertical 371 mm, angle 90.0°).	
2. If the detector angle read-out on the acquisition PC is not 90.0º, use the hand controller to fine adjust until you obtain this reading.	
Detector 1 must be vertical and detector 2 horizontal (within 0.1°) – check with a level.	
3. If the detector vertical position read-out on the acquisition PC is not 371 + 1 /– 0 mm, use the hand controller to obtain this reading.	
4. Measure the free travel range for detector movement in the tower opening.	
This is the distance between the top of the detector arm where it enters the hole in the tower, and the top of the hole. The measured value must be 832 mm +/– 1 mm.	

Procedure	***Details***
5. Use the hand controller to position the detectors horizontally with detector 1 *immediately* adjacent to and touching the table. Use the hand controller Collision Override button for the last approx. 5 – 8 mm.	
The reading for the horizontal position on the acquisition PC must now be 221 +/– 1 mm.	
6. Use the Collision Override button to move the detectors slightly away from the table (until the hand controller LED is not lit any more).	

Note. The horizontal position described above is the same position where the horizontal absolute position encoder is zeroed whereas the vertical position differs. The vertical position encoder is zeroed 790 mm from the top instead of 832 mm.

4.5.3 Verifying Operation within Software Limits

CardioMD system motions operate within two sets of limits. In principle, these function as illustrated in the diagram Figure 4.1.

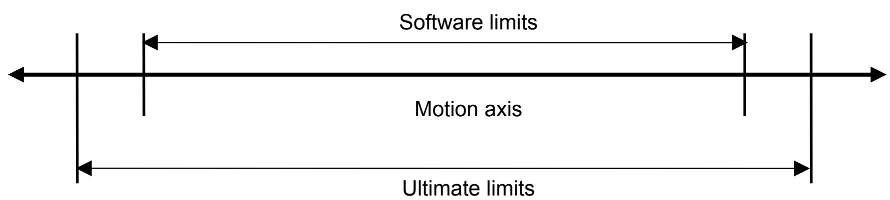


Figure 4.1 CardioMD motion limits

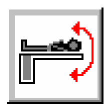
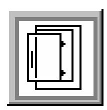
This section tells you how to verify operation within software limits. Section 4.5.4 on page 4-41 gives instructions for verifying ultimate limits.

The gantry must be able to operate within the software limits:

- Horizontal: 0 mm to 495 mm
- Vertical: 231 mm to 1193 mm
- Rotational: –90º to +180º.

The easiest way to verify this is the following sequence.

Procedure	***Details***
1. Place the system in the patient load position.	
2. Move the detector all the way backwards (away from the patient table).	
3. Check max. horizontal reading.	
4. Move the detector all the way downwards as follows:	

Procedure	***Details***
Move the detector as far downwards as the clearance to the floor allows, i.e. until the hand controller LED flashes shortly.	
Then move the detector towards the table until the hand controller LED flashes.	
Then rotate the detector clockwise (the tip of detector 2 coming upwards) until the LED flashes.	
Finally move downwards until the motion stops.	
5. Check min. vertical reading.	
6. On the acquisition PC, click the Patient Load button to return the system to the patient load position using pre-programmed motions.	
7. On the acquisition PC, click the Collimator Exchange button to place the system in the collimator exchange position using pre-programmed motions.	
8. Move the detector upwards as far as it will go. Check max. vertical reading.	
9. Move the detector all the way forwards (over the patient table). Check min. horizontal reading.	
10. Rotate the detector clockwise and counterclockwise, respectively, as far as it will go. Check rotational readings.	
11. Return the system to the patient load position.	

4.5.4 Verifying Ultimate Limit Switches

The ultimate switches must be verified/adjusted *after* the absolute encoders have been calibrated (see section 4.5.2, page 4-39).

With motion controller software release 7MOT0096-N14 and later, SW8 on the motion controllers can no longer be used. Therefore, this section provides two procedures for verifying ultimate switches, one for systems with motion controller software 7MOT0096-N14 and later and one for systems with older software.

To see the version of the motion controller software, check the contents of the most recent logfile in the directory `C:\Cardiocam\SystemLog` on the acquisition PC.

Note. After testing ultimate switches, both motion controllers must be reset and the CardioMD application software restarted.

4.5.4.1 Motion Controller Software 7MOT0096-N14 and Later

CAUTION **Caution**. With motion controller software release 7MOT0096-N14 and later, SW8 on the motion controllers can no longer be used.

The ranges within which the ultimate switches must go active are:

- Horizontal: -7 mm < X_{min} < -2 mm, 497 mm < X_{max} < 505 mm
- Vertical: 218 mm < Y_{min} < 228 mm, 1195 mm < Y_{max} < 1199 mm
- Rotational: Z_{max} > 182°.

Note. It is not possible to approach the rotational ultimate limit by rotating the detector to the Z_{min} < – 90° limit. However, testing the ultimate limit at Z_{max} > 182° alone is sufficient for verification of the functionality, since the same limit switch serves both rotational limits.

Preparing for Testing Ultimate Limit Switches

Testing ultimate limit switches requires the following preparations:

- Removing both table console covers (front and rear – if these have not already been removed)
- Disabling software limits. This is done by sending commands to the master (rotate) motion controller via a HyperTerminal connection
- Starting the CardioMD acquisition software.

Before testing X axis limits, furthermore:

- Removing the patient table pallet.

Before testing Y axis limits, furthermore:

- Removing the patient table pallet
- Rotating the detector assembly to approximately 110°.

Disabling Software Limits

In order to verify ultimate switches, software limits must first be disabled (the diagram in Figure 4.1 on page 4-40 may give you an idea, why). In order to accomplish this, software limits are temporarily set to values well beyond the ultimate limits. For this, you need to establish a HyperTerminal connection to the rotation motion controller (the motion controller to the right).

For instructions on using HyperTerminal for communicating with motion controllers, see Chapter 5 *Diagnostics*, the section *Motion Controller Diagnostics*. Once the HyperTerminal connection is established:

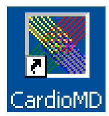
Procedure	*Details*
1. When you see the prompt `->` in the HyperTerminal window indicating that you are communicating with the motion controller, enter the following string of commands:	

```
wrsdo 0x607D 1 -752400 [Enter]
wrsdo 0x607D 2 3762000 [Enter]
wrsdo 0x687D 1 -59904 [Enter]
wrsdo 0x687D 2 8815104 [Enter]
wrsdo 0x707D 1 -5184000 [Enter]
wrsdo 0x707D 2 5184000 [Enter]
```

WARNING

In this mode, all software limits are disabled. Thus, the system must be operated with extreme care.

Starting the CardioMD Application Software

Procedure	***Details***
Before starting the ultimate limit test, make sure to start the CardioMD application software:	
1. Double-click the CardioMD icon on the acquisition PC desktop.	
Note. Ignore any error messages displayed by the acquisition software. You will only need to read the acquisition and gantry parameters displayed at the top of the CardioMD application window (Persistence page).	

Testing Ultimate Limits

Once the software limits have been disabled, it is possible to use the hand controller to move the gantry outside the software limits and thus reach the ultimate limits. This section explains the principle of testing one ultimate limit.

CAUTION

Caution. Before starting to test ultimate limits of one of the motions, make sure to have gone through the necessary preparations listed on page 4-42, such as removing the patient table and / or rotating detectors.

Procedure	***Details***
1. Use the hand controller to drive the axis being tested into a power switch-off.	

CAUTION

Caution. Move the system at low speed when approaching the ultimate level.

Procedure	***Details***
2. Make a note of the read-out of the halt position on the acquisition PC: Check the upper left corner of the CardioMD application window, Det Y, Det X or Det ang field, as appropriate.	
The value must be within the limits specified on page 4-42.	
Should one or more of the limit switches fail the test, look for one of the following causes:	

Procedure	***Details***

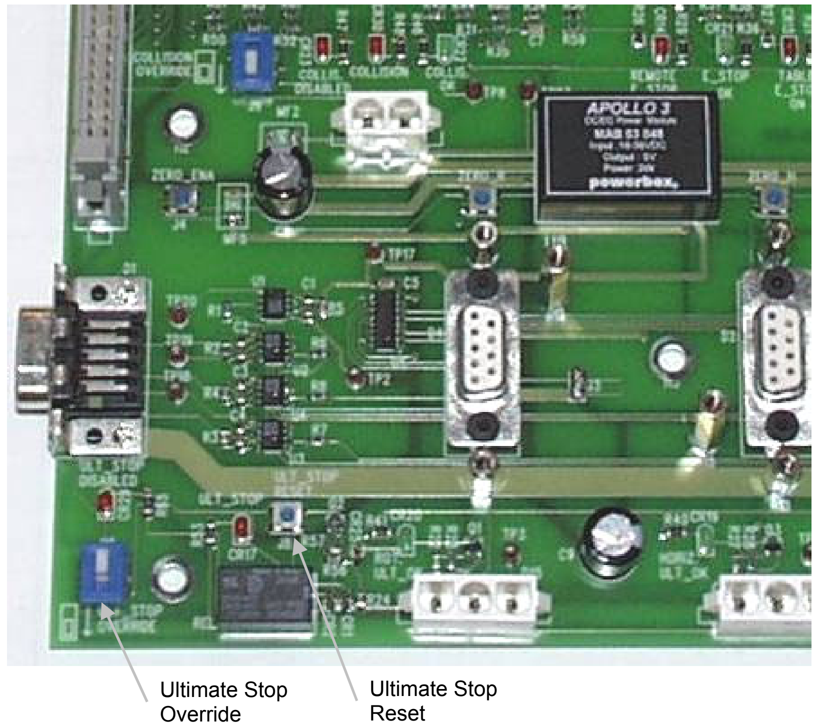
- Cable error
- Switch error
- Calibration error.

Back away from the ultimate limit as follows:

3. Set the Ultimate Stop Override switch on the safety board ON (downwards).

The red LED Ultimate Stop Disabled immediately above the switch goes ON.

4. By means of the appropriate hand controller motion button, move away from the end stop.
5. Press the Ultimate Stop Reset button on the safety board to reset the ultimate stop relay.
6. Check that the red Ultimate Stop LED to the left of the button goes OFF – if it does not, you are not free of the ultimate limit.
7. Set the Ultimate Stop Override switch back to the OFF position (upwards).



CAUTION

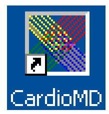
Caution. Be sure to deactivate the Ultimate Stop Override switch before proceeding to test the next ultimate limit. If the Ultimate Stop Override switch is set OFF, you risk hitting a mechanical end stop, possibly damaging the system.

After Testing Ultimate Limit Switches

Note. After testing ultimate switches, both motion controllers must be reset and the CardioMD application software restarted in order to ensure correct display of detector rotation.

Procedure	***Details***

1. Close down the HyperTerminal program on the acquisition PC.
2. Disconnect the RS 232 interface cable.
3. Reset both motion controllers (SW10 in position up).
4. Then remove the reset on the master motion controller (motion controller to the right – SW10 in position down).
5. Finally, remove the reset on the slave mo-

Procedure	*Details*
tion controller (motion controller to the left – SW10 in position down).	
Close down the CardioMD application and then restart it:	
6. Ensure that the acquisition PC is displaying the Persistence page. Click the Close button in the upper right corner of the window.	
7. Wait for at least 10 seconds.	
8. Start the CardioMD application by double-clicking the CardioMD icon on the desktop.	

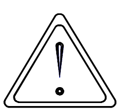
4.5.4.2 Motion Controller Software older than 7MOT0096-N14

The ranges within which the ultimate switches must go active are:

- Horizontal: -7 mm < X_{min} < -2 mm, 497 mm < X_{max} < 505 mm
- Vertical: 218 mm < Y_{min} < 228 mm, 1195 mm < Y_{max} < 1199 mm
- Rotational: Z_{min} < –92°, Z_{max} > 182°.

Note. After testing ultimate switches, both motion controllers must be reset and the CardioMD application software restarted in order to ensure correct display of detector rotation.

Procedure	*Details*
1. Before verifying ultimate switches, set SW8 upwards on both motion controllers.	
It is not necessary to re-boot after changing the state of SW8.	



WARNING

In this mode, all safety/collision software is disabled, so the system must be operated with extreme care.

Procedure	*Details*
When SW8 is activated, it is possible to use the hand controller Collision Override button to position the gantry outside the software limits and thus reach the ultimate limits. Using the Motion Enable button as normally makes the gantry stop at the software limits. Thus, the position of the limits can be verified one by one, for example using the sequence outlined for check of software limits in section 4.5.3.	

WARNING

Especially when moving to the minimum vertical position (see step 4 in section 4.5.3), be very careful not to hit the table or the floor. The collision prevention software is disabled, so the motion will not stop automatically.

Procedure	*Details*
Before verifying ultimate limits:	
2. Remove the patient table and rotate the detectors to approximately 110° prior to checking the vertical lower limit.	
3. Also remove the patient table prior to checking the horizontal forward limit, or ensure that the detectors and rotate arm are above the level of the patient table.	
To check an ultimate limit:	
4. Use the hand controller Collision Override button in combination with the relevant motion button to drive the axis in question into a power switch-off.	
5. Note the read-out of the halt position on the acquisition PC.	
If automated motions are used during this procedure to move the system to the patient load position and to the collimator exchange position, SW8 of both motion controllers and the Ultimate Stop Override switch on the safety board must be in normal position during the motion.	

WARNING

Make sure that the Ultimate Stop Override switch on the safety board and SW8 of both motion controllers are all deactivated when you leave the system.

Procedure	***Details***

To back away from an ultimate limit:

1. Set the Ultimate Stop Override switch on the safety board ON (downwards).

The red Ultimate Stop Disabled LED is lit.

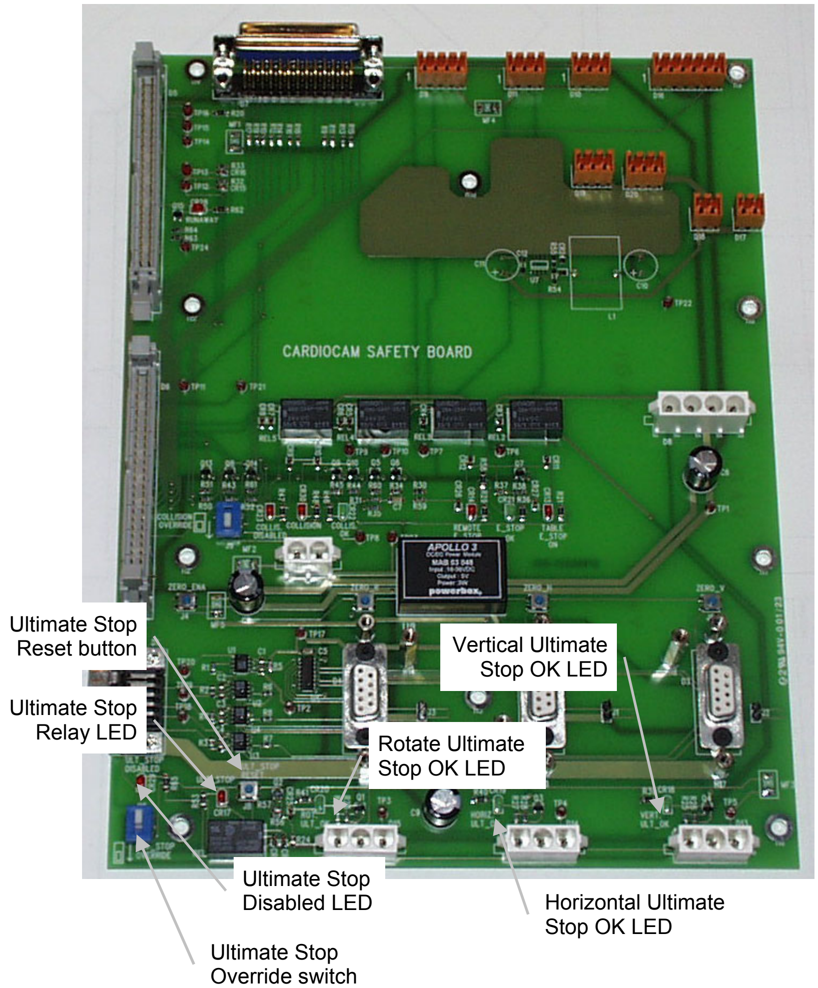
2. Move the axis away from the ultimate stop until the position is within the software limits and the corresponding green LED on the safety board is lit.
3. Press the Ultimate Stop Reset button on the safety board to reset the ultimate stop relay.

The red Ultimate Stop Relay LED must go off, otherwise you are not free of the ultimate limit.

4. Deactivate the Ultimate Stop Override switch.

The red Ultimate Stop Disabled LED goes off.

If the system is not positioned within the software limits, you can only operate the system if SW8 on both motion controllers is active (upward position).

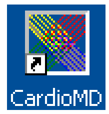


Note. After verifying ultimate limits, it is important to reset both motion controllers and restart the CardioMD application software.

5. Reset both motion controllers (SW10 in position up).
6. Then remove the reset on the master motion controller (motion controller to the right – SW10 in position down).
7. Finally, remove the reset on the slave motion controller (motion controller to the left – SW10 in position down).

If the CardioMD application is running on the acquisition PC, close down the application and then restart it:

8. Ensure that the acquisition PC is displaying the Persistence page. Click the Close

Procedure	***Details***
button in the upper right corner of the window to close the CardioMD application.	
9. Wait for at least 10 seconds.	
10. Start the CardioMD application by double-clicking the CardioMD icon on the desktop.	

5 DIAGNOSTICS

Contents

5.1 Introduction

Diagnostics follow a four-layer scheme:

1. External LED's accessible to operator and service personnel.
2. Internal LED's on electronic modules.
3. Internal electrical test points on modules.
4. Software diagnostics via RS-232 interface to motion controllers and EDC modules and log files on the acquisition PC.

5.2 External LED Indicators

CardioMD offers a number of LED's that are visible from the outside. These LED's are described in the following sections.

The system has three LED's indicating the status of the safety circuit.

III

On Series III systems, these LED's are placed in a panel on the acquisition PC stand.

Figure 5.1 COLLISION, MOTOR POWER and E-STOP status LED's (CardioMD Series III)

I, II

On Series I and II systems, the LED's are located in the upper part of the connector panel on the side of the table console.

Figure 5.2 COLLISION, MOTOR POWER and E-STOP status LED's (CardioMD Series I and II)

During normal operation, only the green MOTOR POWER LED is ON.

The yellow COLLISION LED is lit when the safety circuit is currently registering an impact on one of the collision pads/covers. When this is the case, motions are only possible when the hand controller Collision Override button is pressed. When the impact is removed, the Collision Override button clears the collision state.

The green MOTOR POWER LED must be lit before any motion can take place. If this LED is off, and neither of the adjacent yellow LED's is on, there are 3 possible causes:

- The hand controller Stop button has been pressed.
  In that case, press the Collision Override button.
- A Runaway signal can be issued by either motion controller. The two motion controllers are constantly supervising each other. A missing response from one motion controller makes the other issue a Runaway signal.
  If this is the case, the red RUNAWAY LED on the safety board is lit. Try resetting both motion controllers or rebooting the system.
- The rotate, X or Y motion has exceeded the software-controlled end-stop and reached an ultimate limit.
  If that is the case, the red ULT_STOP LED on the safety board is lit and one or more of the green LED's labeled ULTIM. LIM is off (see Figure 5.5 on page 5-6). In this case, proceed as follows:

1. Set the ULT_STOP OVERRIDE switch on the safety board in position ON (down).
2. Press the hand controller Collision Override button and the relevant motion button to back away from the end stop.
3. Press the ULT_STOP RESET button on the safety board once to reset the stop relay – the red LED should turn off.
4. Set the ULT_STOP OVERRIDE switch back to position OFF (upwards).

The system has a second green LED indicating the status of the system's 115 V AC power output.

III

In Series III systems, this LED is placed on the connector panel at the rear of the table base and indicates the status of the acquisition PC and ECG gate power supply.

Figure 5.3 LED indicating status of 115 V output power (CardioMD Series III)

I, II

On Series I and II systems, the LED is placed in the lower part of the side panel and indicates the status of the acquisition PC power supply.

Figure 5.4 LED indicating status of 115 V output power (CardioMD Series I and II)

If the green LED is OFF, the possible causes are:

- No power to gantry.
  Switch the gantry on by flicking the power switch located at the rear of the table base next to the power connector.
- Primary or secondary fuse on AC power supply blown.
  Replace blown fuses.
- The fuse next to LED needs to be reset.
  Reset fuse. If the problem persists, proceed as follows:
  - III — Series III systems: Remove the ECG gate power cable, wait for 10 seconds, reset fuse, and reconnect power cable.
    If this still does not solve the problem, remove the acquisition PC power cable (internal connection, covers must be removed), wait for 10 seconds, reset fuse and reconnect power cable.
  - I, II — Series I and II systems: Remove the acquisition PC power cable, wait for 10 seconds, reset fuse, and connect the power cable once again.

5.3 Internal LED Indicators

Internal LED’s located on several of the internal modules assist in further diagnosing a fault.

The LED’s on the individual modules are described in the following sections.

5.3.1 LED's on the Safety Board

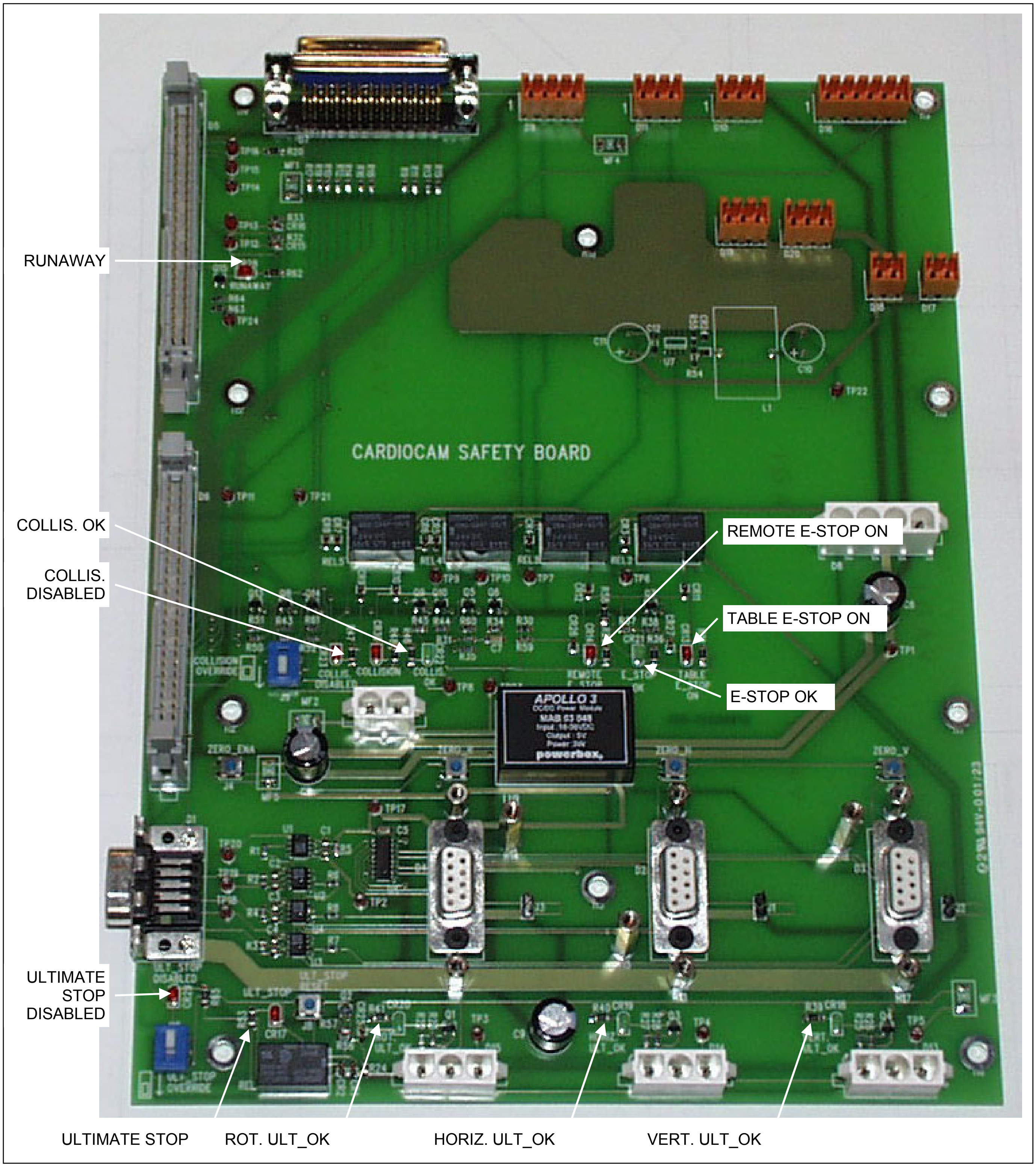


Figure 5.5 LED's on the safety board

COLLIS. OK	This green LED will be on during normal operation. During collision the LED is turned off.
COLLISION	This red LED is on during collision and off during normal operation.
COLLIS. DISABLED	This red LED is on when the Collision Override switch is on (position down) to warn that the collision circuitry is disabled.
ULT_STOP DISABLED	This red LED is on when the Ultimate Stop Override switch is on (position down) to warn that the ultimate stops are disabled.
ROT. ULT_OK	This green LED is on during normal operation. The LED is turned off when the ultimate stop switch on the rotational motion has been triggered (motion limit exceeded), or when either the HORIZ. ULT_OK or VERT. ULT_OK has been triggered.
HORIZ. ULT_OK	This green LED is on during normal operation. The LED is turned off when the ultimate stop switch on the horizontal (X) motion has been triggered (motion limit exceeded), or when VERT. ULT_OK has been triggered.
VERT. ULT_OK	This green LED is on during normal operation. The LED is turned off when the ultimate stop switch on the vertical (Y) motion has been triggered (motion limit exceeded).
E_STOP OK	This green LED is on during normal operation. The LED is turned off when one of the Emergency Stop buttons has been pressed.
TABLE E_STOP ON	This red LED is off during normal operation. The LED is turned on when the gantry E-Stop button has been activated.
REMOTE E_STOP ON	This red LED is off during normal operation. The LED is turned on when the E-Stop button next to the acquisition PC has been activated.
RUNAWAY	This red LED is off during normal operation. The LED is turned on when one of the motion controllers has issued a Runaway signal.

5.3.2 LED's on the Detector Power Supply

Five LED's inside the detector power supply provide information about the integrity of the output voltages.

The LED's are visible through the perforations of the top cover.

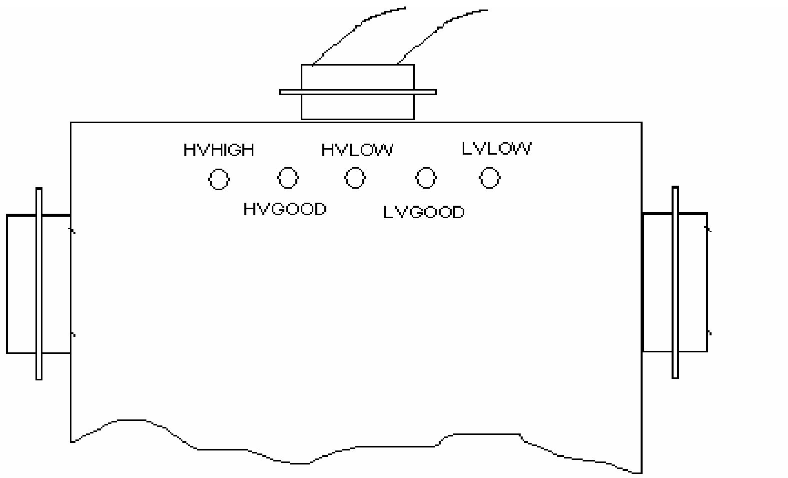


Figure 5.6 LED's on the detector power supply

LED	*COLOR*	*SIGNIFIES*
HVHIGH	RED	High voltage higher than specified setting
HVGOOD	GREEN	High voltage at specified setting
HVLOW	RED	High voltage lower than specified setting or not enabled
LVGOOD	GREEN	All low voltages in specified range
LVLOW	RED	One or more low voltages lower than specified range

Table 5.1 Significance of LED's on the detector power supply

5.3.3 LED's on the Detector EDC Boards

An LED is located on the rear panel of the EDC board (see Figure 5.7 on page 5-9). The LED of the EDC board configured as DET0 (detector 1) should be flashing green at 0.5 Hz indicating that the EDC board is up running. The LED on the EDC board configured as DET1 (detector 2) should be flashing red at the same rate. At power up or reset, the LED will be constantly red.

A flashing red light indicates that an error was detected during power up.

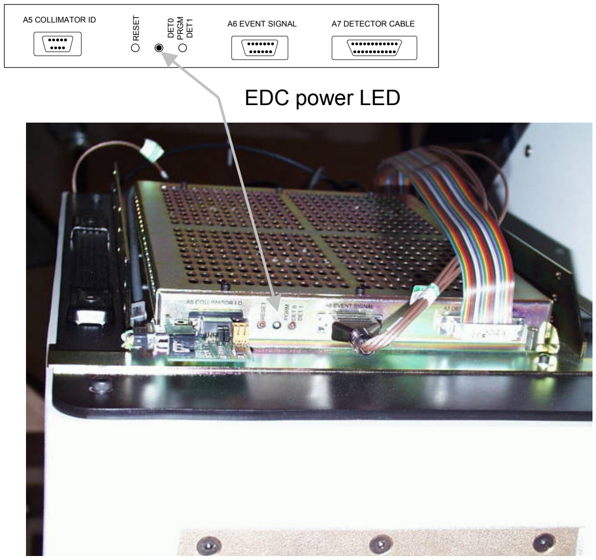


Figure 5.7 EDC module LED

5.3.4 LED’s on the Motion Controllers

Each of the motion controllers has a 20 bit parallel input port and a 12 bit parallel output port. The input ports are pulled up, i.e. a pin with no connection is high.

The status of each bit of the input and output ports is represented on LED panels. Green LED’s are used for the input port and yellow LED’s are used for the outputs. The LED’s are lit when the port signal is pulled low.

Furthermore, 10 green LED’s are provided to monitor the status on the detector drives (i.e., the motion controllers’ control and encoder ports).

5.3.4.1 Rotate Motion Controller Port Assignments

Input Port

Port	*Signal*	*Polarity when active*	*LED when system is ready*
IN00	Table mid-position	N/A	–
IN01			OFF
IN02			OFF
IN03			OFF
IN04			OFF
IN05			OFF
IN06			OFF
IN07			OFF
IN08	Motor power not present	High (LED Off)	ON
IN09			OFF
IN10	U-stop disabled	Low (LED On)	OFF
IN11	Collision disabled	Low (LED On)	OFF
IN12	Collision active	High (LED Off)	ON
IN13	Runaway/Stop	Low (LED On)	OFF

Port	*Signal*	*Polarity when active*	*LED when system is ready*
IN14	Remote E-stop	High (LED Off)	ON
IN15	Table E-stop	High (LED Off)	ON
IN16	Y U-stop active	High (LED Off)	ON
IN17	X U-stop active	High (LED Off)	ON
IN18	Z U-stop active	High (LED Off)	ON
IN19	U-relay (latched U-stop)	Low (LED On)	OFF

Table 5.2 Rotate motion controller input port

Output Port

Port	*Signal*	*Explanation*
OUT00	Runaway_1	Runaway output LED must be on when the system is running normally When the LED is off, the rotate motion controller has made an emergency stop
OUT01	Table In	Output for driving the table inwards Active low
OUT02	Table Out	Output for driving the table outwards Active low
OUT03	HS Override LED	Output for driving the hand controller LED Active low
OUT04	Trajectory active	Debug use only
OUT05	Not used	
OUT06	T8 LED	Dimly lit during normal operation (timer interrupt running)
OUT07	Clearance failure	Lit if the detectors are too close to the table or the gantry base The system can only be operated using OVERRIDE on the hand controller
OUT08	Active & OK	Flashes with a frequency of 0.5 Hz when the controller is running
OUT09	Diagnostics OK	If the power-up self test is succesfully passed, this LED is lit If the Node ID (CAN Bus address, switch 1 – 5) is incorrect, (i.e. neither rotate nor linear), this LED flashes
OUT10	NMI – power fail	If the supply voltage to the controllers dips, the controller stops normal operation and this LED flashes with a frequency of 1 Hz
OUT11	Not used	
CHA POS	Pos. analog control voltage to rotate amplifier	Light is roughly proportional to the motor control voltage output when positive
CHA NEG	Neg. analog control voltage to rotate amplifier	Light is roughly proportional to the motor control voltage output when negative
CHB POS	Not used	
CHB NEG	Not used	

Table 5.3 Rotate motion controller output port

Channel status

Port	*Signal*	*Explanation*
CHA_FAULT	Rotate amp. fault	High (LED Off) during normal use Low (LED On) when motor power is not present
CHA_LR	Not used	
CHA_LL	Not used	
CHA_BRK	Not used	
CHA_ENA	Rotate amp. enable	Low (LED On) during normal use High (LED On) when motor power is not present
CHB_ENA	Not used	
CHB_BRK	Not used	
CHB_LL	Not used	
CHB_LR	Not used	
CHB_FAULT	Not used	

Table 5.4 Rotate motion controller channel status

5.3.4.2 Linear Motion Controller Port Assignments

The only signals connected to the input port of the linear motion controller are the hand controller inputs. All buttons are low, (i.e., the LED is lit when the button is pressed). The Stop button is not connected to the motion controller.

Input port

Port	*Signal*
IN00	HS Motion Enable
IN01	HS Mark
IN02	HS X Out
IN03	HS X In
IN04	HS Table Out
IN05	HS Table In
IN06	HS Y Up
IN07	HS Y Down
IN08	HS Rotate CCW
IN09	HS Rotate CW
IN10	HS Start ACQ
IN11	HS Collision Override
IN12	
IN13	
IN14	
IN15	
IN16	
IN17	
IN18	
IN19	

Table 5.5 Linear motion controller input port

Output Port

Port	*Signal*	*Explanation*
OUT00	Runaway_2	Runaway output LED must be on when the system is running normally When the LED is off, the linear motion controller has made an emergency stop
OUT01	Not used	
OUT02	Not used	
OUT03	Not used	
OUT04	Not used	
OUT05	Not used	
OUT06	T8 LED	Dimly lit during normal operation (timer interrupt running)
OUT07	Not used	
OUT08	Active & OK	Flashes with a frequency of 0.5 Hz when the controller is running and sync messages are received from the rotate motion controller
OUT09	Diagnostics OK	If the power-up self test is succesfully passed, this LED is lit If the Node ID (CAN Bus address, switch 1 – 5) is incorrect (i.e. neither rotate nor linear), this LED flashes
OUT10	NMI – power fail	If the supply voltage to the controllers dips, the controller stops normal operation and this LED flashes with a frequency of 1 Hz
OUT11	Not used	
CHA POS	Pos. analog control voltage to Y amplifier	Light is roughly proportional to the motor control voltage output when positive
CHA NEG	Neg. analog control voltage to Y amplifier	Light is roughly proportional to the motor control voltage output when negative
CHB POS	Pos. analog control voltage to X amplifier	Light is roughly proportional to the motor control voltage output when positive
CHB NEG	Neg. analog control voltage to X amplifier	Light is roughly proportional to the motor control voltage output when negative

Table 5.6 Linear motion controller output port

Channel status

Port	*Signal*	*Explanation*
CHA_FAULT	Y amp. fault	High (LED off) during normal use Low (LED on) when motor power is not present
CHA_LR	Not used	
CHA_LL	Not used	
CHA_BRK	Not used	
CHA_ENA	Y amp. enable	Low (LED on) during normal use High (LED on) when motor power is not present
CHB_ENA	X amp. enable	Low (LED on) during normal use High (LED on) when motor power is not present
CHB_BRK	Not used	
CHB_LL	Not used	
CHB_LR	Not used	

Port	*Signal*	*Explanation*
CHB_FAULT	X amp. fault	Low (LED on) during normal use High (LED off) when motor power is not present

Table 5.7 Linear motion controller channel status

5.4 Test Terminals

The electronic modules within CardioMD offer a number of test pins for diagnostics.

5.4.1 Gantry

5.4.1.1 Test Terminals on the Safety Board

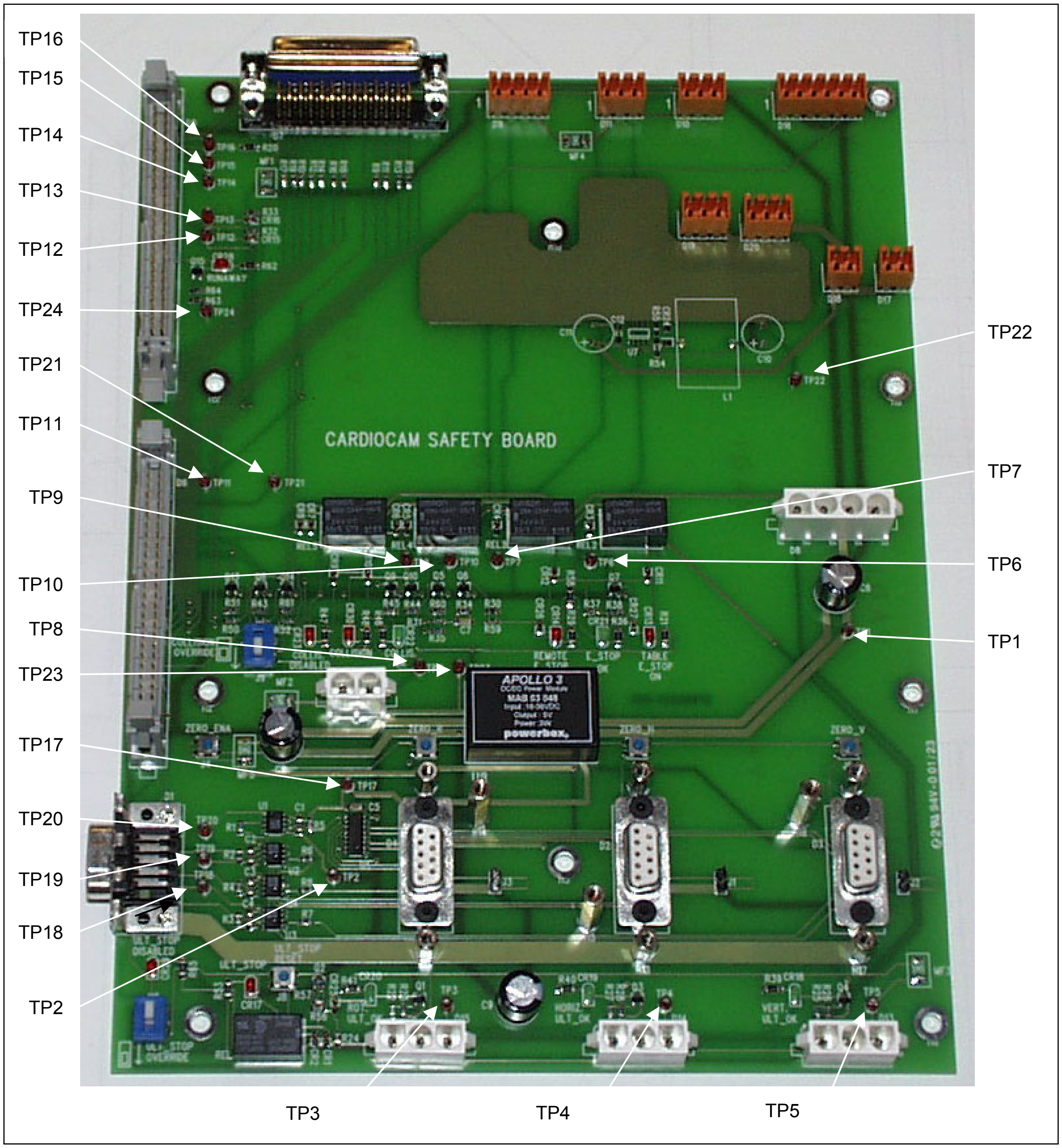


Figure 5.8 Safety board test terminals

Test Terminal	*Description*
TP1	+24 V DC power input
TP2	Return (reference) for the +24 V DC power input
TP3	+24 V DC if vertical and horizontal ultimate stop switches are OK and if multifuse MP3 on the safety board is not blown. Otherwise the voltage reading is 0 V DC
TP4	+24 V DC if rotational ultimate stop switches are OK and if multifuse MP3 on the safety board is not blown. Otherwise the voltage reading is 0 V DC
TP5	+24 V DC if multifuse MP3 is OK. If the fuse is blown, the voltage reading is 0 V DC
TP6	+24 V DC if the table (gantry) E-Stop is not engaged and multifuse MP4 on the safety board is not blown. Otherwise the voltage reading is 0 V DC
TP7	+24 V DC if the remote E-Stop (next to the acquisition PC) is not engaged and multifuse MP4 on the safety board is not blown. Otherwise the voltage reading is 0 V DC
TP8	+24 V DC if the collision circuit (pads or covers) is not detecting a collision and multifuse MP2 on the safety board is not blown. Otherwise the voltage reading is 0 V DC
TP9	+24 V DC during normal operation. Signal goes to approx. 0 V DC when one of the stop buttons is pressed (E-Stop or hand controller Stop). After activation of the hand controller Collision Override button, the signal once again goes to +24 V DC
TP10	Not to be used by Service
TP11	Status of table position switch. A transition from 0 to +4 V DC or from +4 to 0 V DC indicates that the table is passing its center position as used for patient load positioning
TP12	0 V DC. If +12 to 16 V DC is measured, the master motion controller has issued a Runaway fault
TP13	0 V DC. If +12 to 16 V DC is measured, the slave motion controller has issued a Runaway fault
TP14	Approx. 0 V DC indicates that the table is moving inwards. +24 V DC indicates that the table is not moving inwards
TP15	Approx. 0 V DC indicates that the table is moving outwards. +24 V DC indicates that the table is not moving outwards
TP16	Hand controller LED drive signal. If +24 V DC the hand controller LED is off. If approx. 0 V DC the hand controller LED is on
TP17	+ 5 V DC. Internally generated and used voltage
TP18	Return (reference) for TP19 and TP 20
TP19	Motion controller + 5 V used internally on the safety board
TP20	Master motion controller burst clock output to read positions from the three absolute encoders. Signal transition between approx. 0 and +5 V
TP21	Return (reference) for the +24 V DC power input
TP22	Return (reference) for the +24 V DC power input
TP23	Return (reference) for the +24 V DC power input
TP24	0 V DC during normal operation. If +12 to 16 V DC, one of the motion controllers has issued a Runway fault

5.4.2 Detector

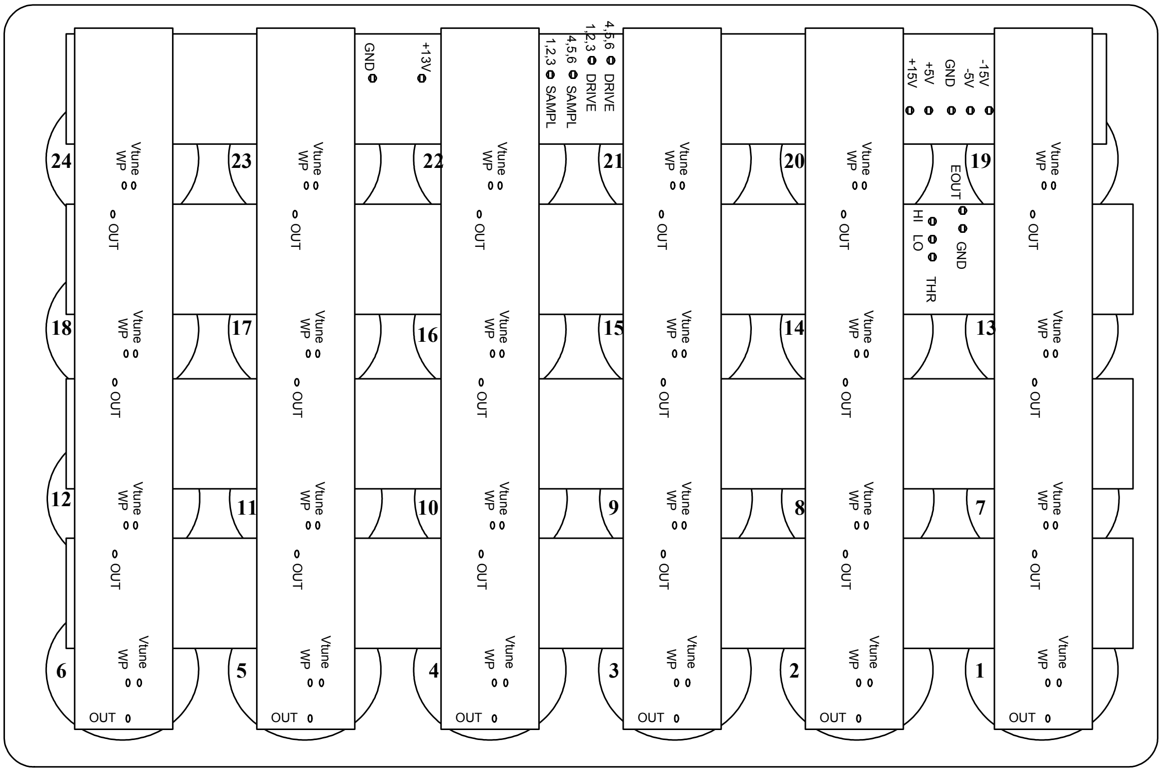


Figure 5.9 Location of detector test points

5.4.2.1 PMT Strips

All measurements are referenced to GND, which is represented by any of the mounting screws.

Vtune — is a DC test point that reflects the tune value for the particular PMT.
Range: 0 – 5 V = digital tune value 0 – 1023.

WP — is a DC test point that reflects that the autotune loop on the particular PMT is operational. At normal operation, the voltage reading should be 2 – 4 V. If the voltage reading is lower or negative, then the inherent PMT gain is too low. In that case, either the high voltage is too low or the PMT is defective

OUT — is an oscilloscope test point showing the output from the PMT preamplifier. The magnitude of scintillation signals from technetium or cobalt should be around 4 – 5 Vpp. Base line should be 0 V ± 30 mV.

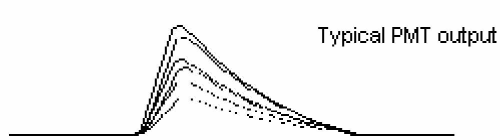


Figure 5.10 Typical PMT output

5.4.2.2 POWER Strip

All measurements are referenced to local GND pins on the power strip.

+15V, +5V, –5V, –15V, +13V are DC test points for the low voltages used in the detector. The readings should be within 5% of these values.

DRV 1-2-3 is an oscilloscope test point for the autotune LED drive signal serving PMT # 1, 2, 3, 7, 8, 9, 13, 14, 15, 19, 20, and 21.

DRV 4-5-6 is an oscilloscope test point for the Autotune LED drive signal serving PMT # 4, 5, 6, 10, 11, 12, 16, 17, 18, 22, 23 and 24.

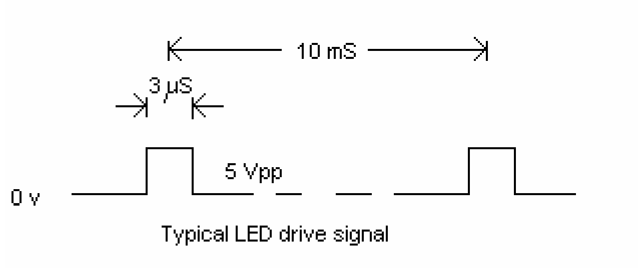


Figure 5.11 LED drive signal

SMPL 1-2-3 is an oscilloscope test point for the Autotune LED sample signal serving PMT # 1, 2, 3, 7, 8, 9, 13, 14, 15, 19, 20, and 21.

SMPL 4-5-6 is an oscilloscope test point for the Autotune LED sample signal serving PMT # 4, 5, 6, 10, 11, 12, 16, 17, 18, 22, 23 and 24.

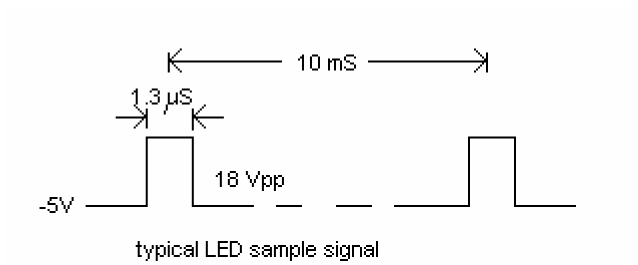


Figure 5.12 LED sample signal

5.4.2.3 X–E Strip

E-OUT is an oscilloscope test point showing the Energy output signal to the EDC board. The magnitude of scintillation signals from technetium or cobalt should be around 0.8 – 1.0 Vpp, negative going. Base line should be 0 V ± 50 mV.

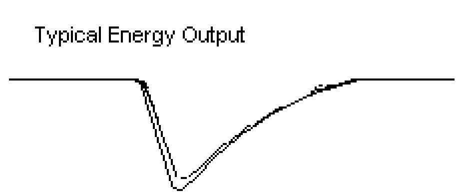


Figure 5.13 Typical Energy output signal

HIDYN is an oscilloscope test point showing the high level DynCor signal. The magnitude of scintillation signals from technetium or cobalt should be around

	1.0 – 1.6 Vpp. Base line should be 0 V ± 10 mV.
LODYN	is an oscilloscope test point showing the low level DynCor signal. The magnitude of scintillation signals from technetium or cobalt should be around 0.4 – 0.8 Vpp. Base line should be 0 V ± 10 mV.

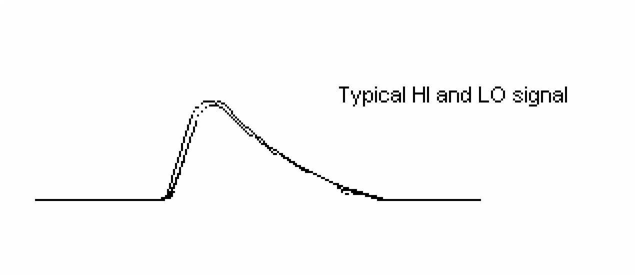


Figure 5.14 Typical HIDYN and LODYN signals

THRESH	is an oscilloscope test point showing the Threshold signal. The magnitude of scintillation signals from technetium or cobalt should be around 0.15 – 0.30 Vpp. Base line should be 0 V ± 10 mV.

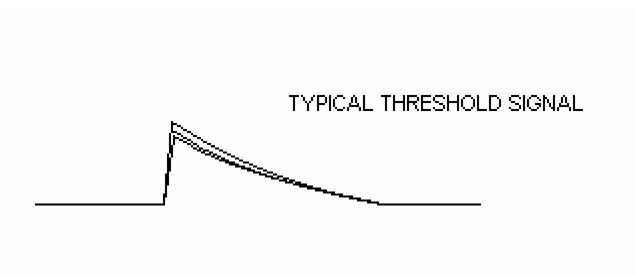


Figure 5.15 Typical Threshold signal

5.5 False Collisions

5.5.1 Locating the Cause of a False Collision

Under normal operation, the CardioMD system detects a collision by performing a logical OR operation on the input signals from the individual collision sensors. These sensors include:

- Collimator surface sensor, detector I
- Collimator surface sensor, detector II
- Detector edge sensor, detector I
- Detector edge sensor, detector II
- Detector end cover sensor, detector I
- Detector end cover sensor, detector II
- Detector top cover sensor
- Rotate gear cover sensor.

To locate a cause of a false collision, it is practical to disable the sensors one by one in order to determine whether one of the sensors is causing the problems.

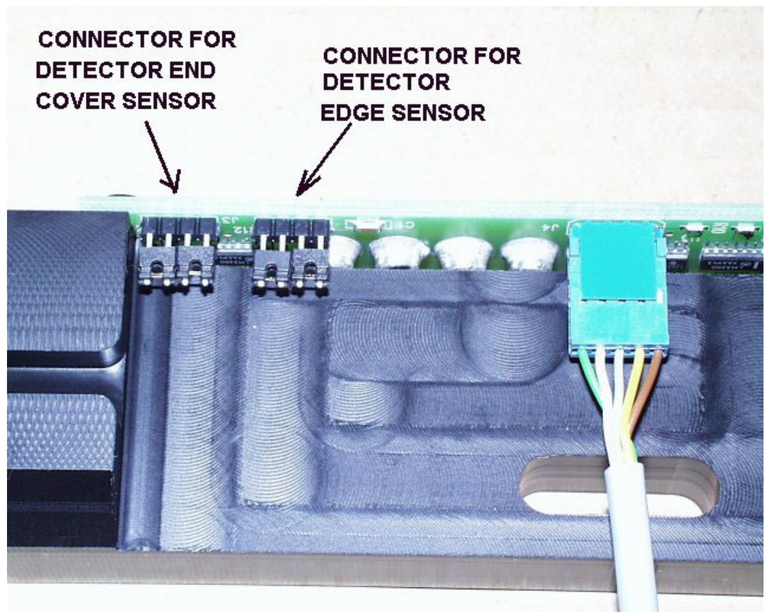
Note. The collision circuit will report a collision when it detects:

- An open circuit
- A short-circuit.

All sensors must have a resistance of approximately 20 kΩ in the non-collision state.

5.5.1.1 Disabling Detector Edge Sensors and Detector End Cover Sensors

Detector edge sensors and detector end cover sensors should be disabled on both detectors. Proceed as follows:

Procedure	*Details*
1. Remove the detector side cover	
2. Remove the detector edge cover.	
3. Locate the connectors for the end cover sensor and for the edge sensor. See photo on the right.	
4. Disconnect one or both of the sensors as required.	
5. Place two jumpers on each connector as shown in photo.	
This will establish a 20 kΩ substitute resistance for each of the disconnected sensors.	

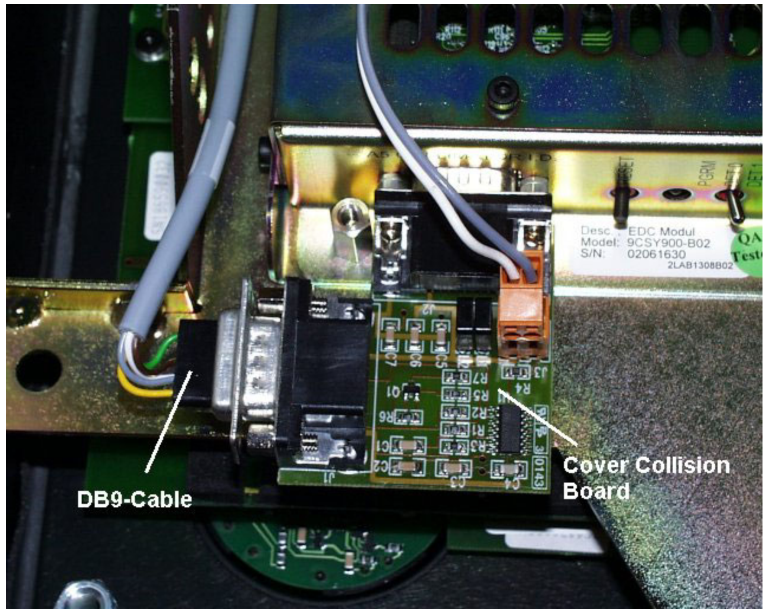
5.5.1.2 Disabling Detector Top Cover Sensor and Rotate Gear Cover Sensor

Procedure	*Details*
1. Remove the detector top cover.	
2. Locate the two cover collision boards.	
The collision board that plugs into the EDC board of detector 1 serves the detector top cover sensor.	
The collision board that plugs into the EDC board of detector 2 serves the rotate gear cover sensor.	

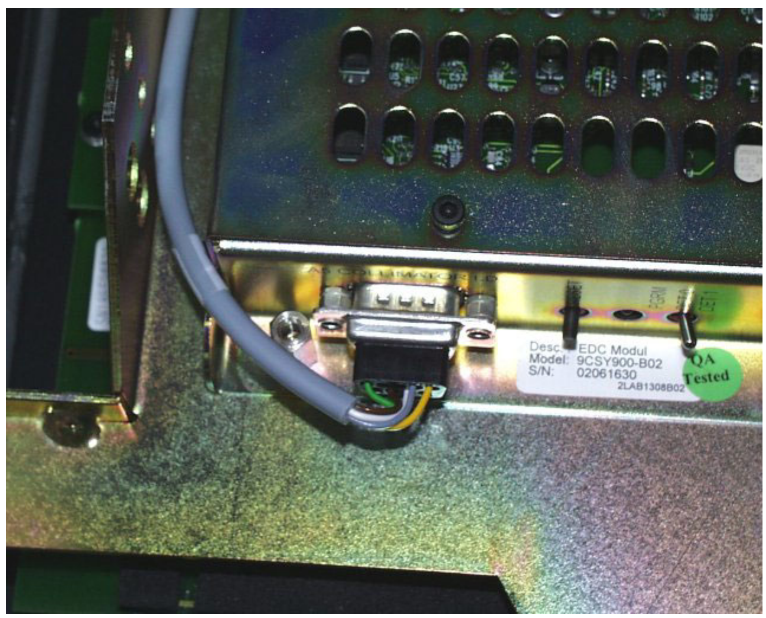
Procedure	***Details***

To disable one or both sensors:

3. Remove the DB9-cable from the appropriate cover collision board.



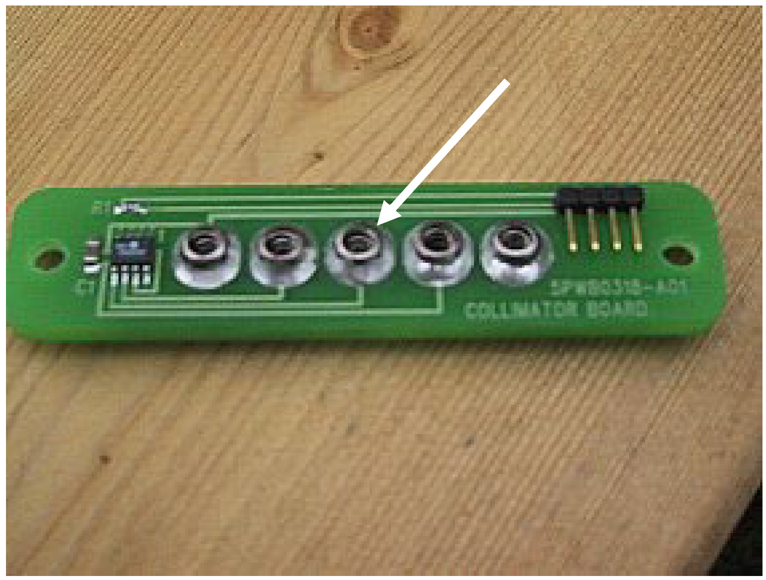
4. Unscrew the cover collision board and plug the DB9-cable directly into the EDC board.



5.5.1.3 Corrosion on Contact Prints

If disabling the detector collision sensors one by one does not yield a solution to the problem of false collisions, the cause may reside in corrosion around the small steel balls on either the detector ID board or the collimator ID board.

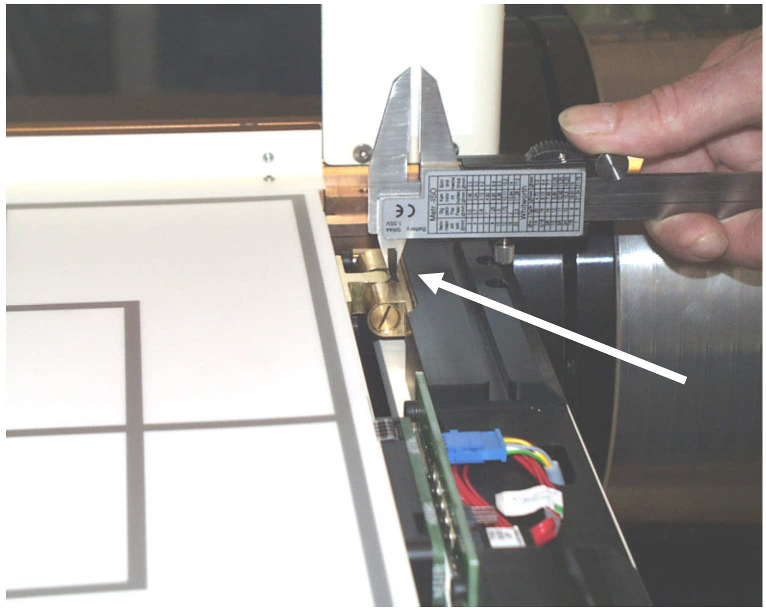
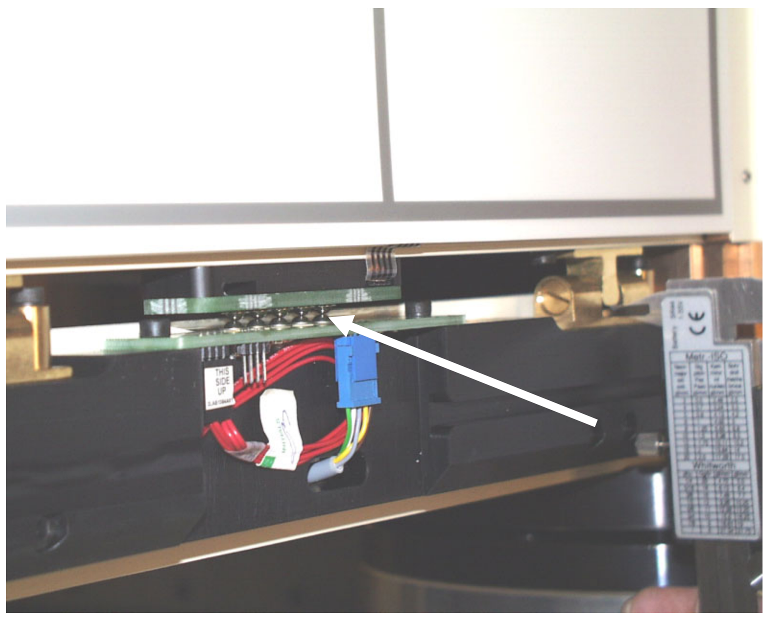
Proceed as follows:

Procedure	*Details*
1. Try cleaning the contact balls with alcohol. If this does not solve the problem, the springs behind the contact balls may be corroded. See photo on the right. In this case: 2. Replace the detector ID board and/or the collimator ID board. The mechanical replacement of either board is straightforward. When the collimator ID board has been replaced, the new ID board must be programmed with collimator type information. See instructions in Chapter 7 *Software Update Procedures*, the section *Collimator ID Programming*.	

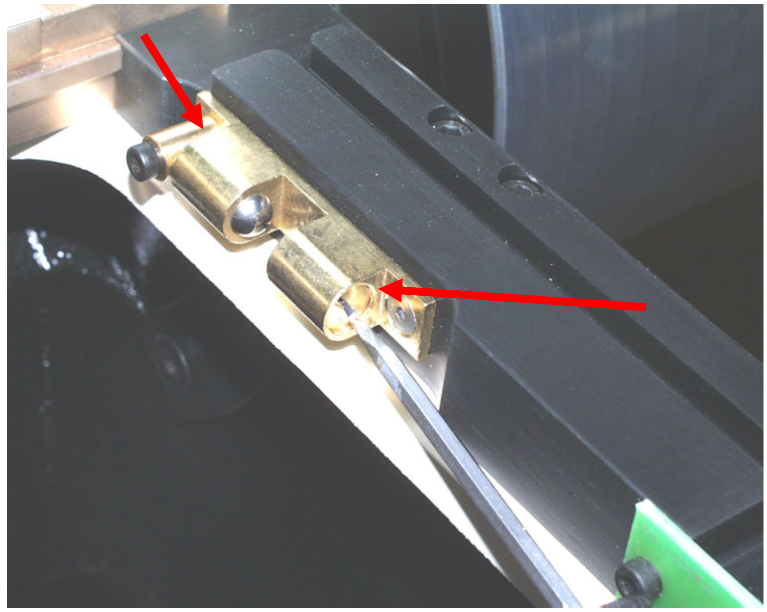
5.5.1.4 Checking Pressure on Contact Balls

When electrical causes for false collisions have been ruled out (by following instructions given in the previous sections), you should check whether the adjustment of collimator locks could be the cause.

Procedure	*Details*
Measure the distance between the collimator ID board and detector ID board when the contact balls are just touching each other. 1. Remove the detector side cover. 2. Remove the detector edge cover. 3. While sliding in the collimator, hold a small piece of paper between the boards until the paper is just caught between the contact balls.	

Procedure	***Details***
4. Measure the gap in both collimator locks as shown in the photo on the right. This gap should be 1.5 – 2.0 mm.	
5. Check that all five ball contacts are engaging at the same point. The contact balls must be evenly soldered and none of the boards must be bent. 6. Push in the collimator all the way. Check that both collimator locks are fully engaging (no gap).	

5.5.1.5 Checking Collimator Lock Pressure

Procedure	***Details***
The two collimator locks must give a distinct click when engaging/disengaging. If this is not the case, or if the locks are not applying sufficient pressure to ensure that the contact balls are firmly pressed together, the tension of the locks be adjusted. 1. Adjust lock tension by turning the two adjustment screws on each lock. See the photo on the right.	

5.6 Diagnostic Software Utilities

The CardioMD system provides the following tools for software diagnostics:

- RS-232 access to motion controllers and EDC modules
- FireViewer to check Firewire communication
- Error logs on Acquisition PC.

Accessing and using software diagnostic utilities are described in the following sections.

5.6.1 Motion Controller Diagnostics

The CardioMD motion controllers have a serial port that can be used for troubleshooting purposes using various utilities resident within the firmware of the motion controller. This section identifies only a few commands that may be helpful in troubleshooting CardioMD system-related failures.

5.6.1.1 Tools Required

- A special RS 232 cable, part no. 9CBL0818.
- III When using a laptop acquisition PC (CardioMD Series III): An USB to RS 232 adapter, part no. 3ACQ1669.

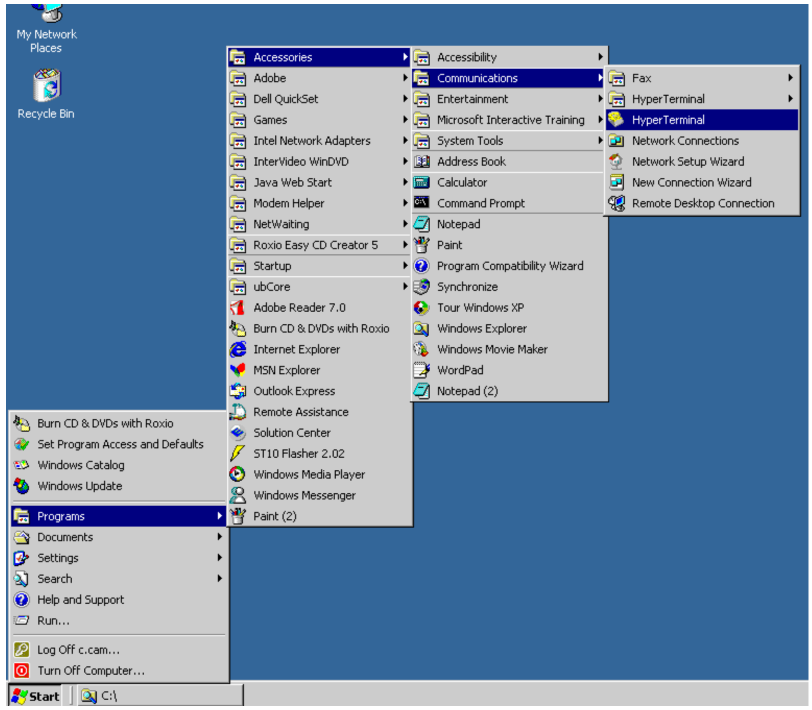
5.6.1.2 Configuring HyperTerminal for Terminal Access to Motion Controllers

Procedure	*Details*
1. Connect one end of the serial interface cable to the motion controller serial port labeled BZ2 RS232.	
This does not require that any other cables already connected to the motion controller are removed.	
With a laptop acquisition PC (CardioMD Series III):	III
2. Use the USB to RS 232 adapter to connect the opposite end of the serial interface cable to one of the acquisition PC's USB ports.	
With a tower acquisition PC (CardioMD Series I and II):	I, II
3. Connect the opposite end of the cable to the COM1 serial port on the CardioMD Acquisition PC.	
It is not necessary to use a null modem cable adapter to communicate with the motion controllers.	I, II III

Procedure	***Details***

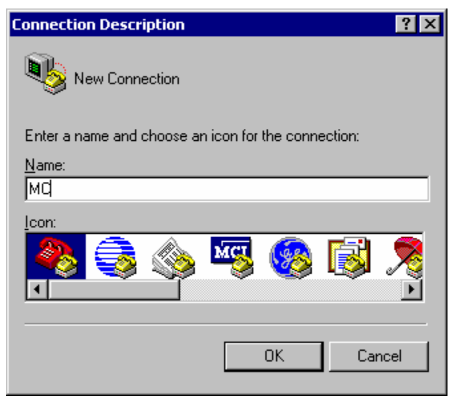
4. In the Windows Start menu, select **Programs**, **Accessories**, **Communications** and **HyperTerminal**.

Note. The screen pictures shown on this page are from a Windows XP installation. However, the Windows 2000 user interface is very similar to these.



HyperTerminal displays the connection Description window.

5. In the Name field, enter MC, and select OK.



HyperTerminal displays the Connect To dialog.

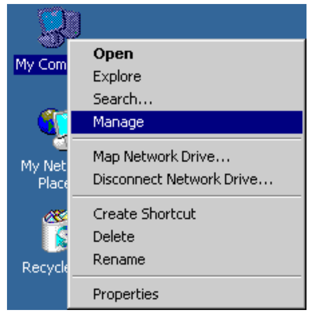
When using a laptop acquisition PC, you may need to check which COM port the USB to RS 232 adapter uses:

III

Procedure	***Details***

6. On the acquisition PC's desktop, right-click the My Computer icon and select Manage from the pop-up menu.

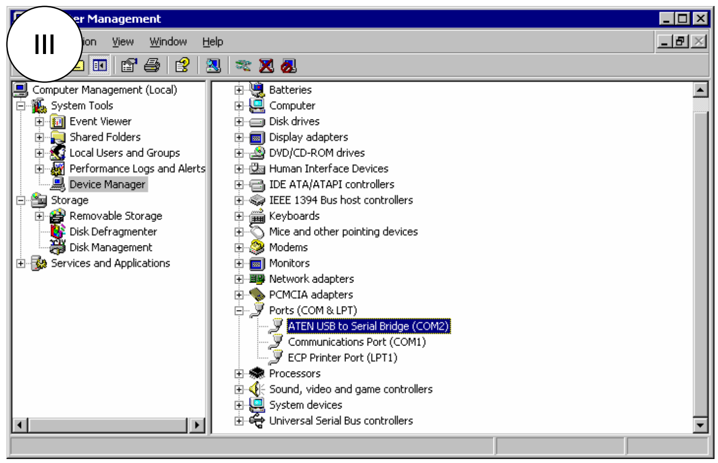
III



The Computer Management window appears.

7. In the left-hand pane, select Device Manager.
8. In the right-hand pane, click the + next to the entry Ports (Com & LPT).
9. Check the COM port number stated next to the item ATEN to USB Serial Bridge.

III



On a tower acquisition PC, you must use COM1.

I, II

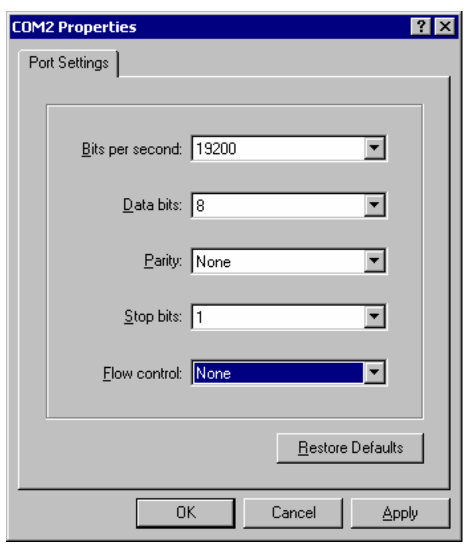
10. Ensure that the correct COM port is selected.

I, II   III

11. Click OK to continue.

The COM Properties dialog appears.

12. Set the following parameters for the serial interface:
    Baud rate: 19200
    Data bits: 8
    Parity: None
    Stop bits: 1
    Flow control: None.



13. Select OK to continue.

The HyperTerminal main window appears.

Procedure	***Details***

14. In the menu bar, select **File**, **Properties**.

The MC Properties dialog appears.

15. Click the Settings tab.

This allows you to set configure the terminal emulation.

16. In the Emulation drop-down, select VT100 and click OK.

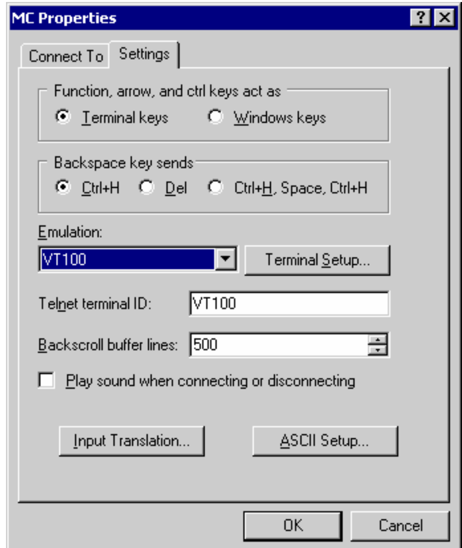
HyperTerminal is now ready to communicate with the motion controller.

To make the motion controller display its `->` prompt in the HyperTerminal main window:

17. Press [Enter].

This should cause the MC prompt to appear.

For further details, see section 5.6.1.3.



5.6.1.3 CardioMD Motion Controller Command Definitions

The commands listed below are only accessible via the motor controller serial port labeled BZ2 RS-232. These commands are useful for diagnosing system failures and intermittencies.

Boot prompt

When the motion controller boots, it issues the message:

```
@
@CardioMD Motion Controller
@Hardware version 9MOT0918
@Software version 7MOT0096-nnn
@Compile time     Sep 19 2001 - 09:47:34
@
NodeID = 36 - This node should be controlling Rotate
->
```

`nnn` represents the actual software version, e.g. G07. The hardware version given is a comment; it is *not* read from the actual hardware.

The message shown is for the rotate controller; the linear controller displays the following NodeID information:

```
NodeID = 35 - This node should be controlling Linear
```

If you press [Enter], you should now receive a renewed prompt (`->`). If the motion controller DIP switch is set erroneously, you receive the following message:

```
NodeID = {what the switch is set to} - This node should be
controlling **NOTHING**
***THIS SWITCH SETTING IS INVALID
```

If SW8 is set, a warning message is displayed:

```
***********************************
*** Safety overrule mode enabled ***
***********************************
```

Command list

If you enter a `?`, the motion controller prints a list of commands – optional parameters are listed in { }:

```
?
RDB          Read byte                    {Address}
WRB          Write byte                   {Address,Value}
RDW          Read word                    {Address}
WRW          Write word                   {Address,Value}
RDL          Read long                    {Address}
WRL          Write long                   {Address,Value}
PRGAVR       Program AVR                  {1|2}
VERAVR       Verify AVR                   {1|2}
TIME         Print time since reset
POS          Print incremental
             positions
APOS         Print absolute positions
TVEL
RDSDO        Read from object             {Index,[SubIndex]}
             dictionary
WRSDO        Write to object              {Index,SubIndex,Value}
             dictionary
RPDO         Simulate receive PDO         {PDOnr,Data,...}
TPDO         Send transmit PDO            {PDOnr}
CSDO         Client SDO                   {R|W,Index,Subindex,Value}
CPSDO        Copy SDO from server         {Index,Subindex}
GETNODEID    Print node ID
STATUS       Show status word
MOVE, MOV    Move to absolute position    {1|2,Position}
REL          Move relative to actual      {1|2,Position}
             position
SPEED,       Set/Get Velocity             {1|2,[Velocity]}
VEL
ACC          Set/Get accelerations        {1|2,[Acc,[Stop]]}
STOP         Stop motion(s)               {[1|2]}
ERRLOG       Set error logging flags      {[Flags|Blank=HELP]}
S, SETPIN    Set output pin high          {0..11,0..11,...}
C, CLRPIN    Set output pin low           {0..11,0..11,...}
IN           Print input pins
PID          Set/Get PID gain parameters {[1|2,[P,[I,[D,[IL]]]]]}
P            Set/Get PID proportional     {[P]}
             gain
I            Set/Get PID integration      {[I]}
             gain
```

```
D           Set/Get PID differential    {[D]}
            gain
SSB         Set status bits             {1|2|3,Mask}
CSB         Clear status bits           {1|2|3,Mask}
PSD         Print SetPoint Data         {1|2|3}
EXERCISE    Continuous motion           {1|2|3,MinPos,MaxPos}
            exercise
RALPHA      Print rotational
            parameters
CC          Check clearance
RA          Show runaway status
RSCR        Read motion scripts
VERSION     Print version information
GETDEBUG    Print debug buffer          {[n]}
SSCTX       Transmit one word on SSC
BAUD        Change baud rate            {9600|19200|38400|57600}
HELP, ?     Print list of commands
->
```

The most relevant of these commands are described later.

CAUTION

Caution. By using some of these commands, especially the ones not described in detail in this manual, you can seriously jeopardize the operation of the motion controller – with the possibility of imposing damage to persons and/or the gantry.

Logging

The logging facility provides you with more or less detailed information. By default, all logging is set off.

The command `errlog` without any parameters makes the motion controller return a list of the possibilities:

```
-> errlog
Logging Help:
   0x0001=CAN
   0x0002=CANOPEN
   0x0004=CANREPORT
   0x0008=CANPDOS
   0x0010=MOTION LOG X
   0x0020=MOTION LOG Y
   0x0040=MOTION LOG Z
   0x0080=MOTION
   0x0100=HANDSET
   0x0200=SSC
   0x0400=TRAJECTORY
   0x0800=ROTATION
   0x1000=PID X
   0x2000=PID Y
   0x4000=PID Z
   0x8000=VELOCITIES
Logging Level = All logging disabled!
```

The logging setting is the result of an OR operation on these individual hexadecimal values. For example, specifying `errlog 0x0180` enables logging of HANDSET and MOTION.

The X, Y, Z logging only applies to the pertinent motion controller:

X – Linear controller

Y – Linear controller

Z – Rotate controller (Z is an alias for the rotate axis).

If you enable CAN, CANOPEN, and CANREPORT, you get a logging of all activity on the CANbus that can be seen by this motion controller, with the exception of the CANbus messages generated by the motion controller itself. Only the rotate controller generates CANbus messages. To see the messages generated by this motion controller to the PC (PDO's), you must enable CANPDOS. Alternatively, you can connect the terminal to the linear motion controller and monitor the traffic on the CANbus from there.

Note. PDO's are only sent when the motion controller state is OPERATIONAL, i.e. when the acquisition PC has established contact. You can check the state by pressing [Ctrl-Q].

Further useful settings:

MOTION — When this mode is enabled, relevant information regarding the motions controlled by this motion controller are provided, such as motion start and stop, faults encountered etc. This setting is useful on both controllers. It is the default setting for the linear motion controller

HANDSET — Displays the hand controller key actions. The setting is only useful for the rotate motion controller

TRAJECTORY — When this mode is enabled, the different states of the trajectory calculation is displayed. The setting is only useful on the rotate motion controller (default setting).

Commands

Some of the motion controller interface commands are described in detail below. The remaining commands are only included for software debugging purposes.

Some of the commands are only meaningful for one of the controllers while others can be used with both controllers.

Command	*Rotate controller*	*Linear controller*
`RDB`, `WRB`, `RDW`, `WRW`, `RDL`, `WRL`	Direct read/write of the processor memory/registers *Do not use*	
`PRGAVR`	Used to program the AVR microcontrollers. If this should ever be necessary, you will receive detailed instructions	
`VERAVR`	Verification of the AVR microcontroller flash memory	
`TIME`	The system has a 1-second time tag you can read using this command. The time restarts when the controller is booted	
`APOS`	Rotate: Reads out (x,y,z) position – x,y in 1/10 mm, z in 1/100 degree	Linear: Not valid for linear controller
`TVEL`	Rotate: Reads out actual (x,y,z) velocities – x,y in 1/10 mm/s, z in 1/100 degree	Linear: Not valid for linear controller

Command	***Rotate controller***	***Linear controller***
`RDSDO`	Read from Object Dictionary. The Object Dictionary holds settings and status. Each entry has an index and a sub-index. *Do not use unless you receive further instructions*	
`WRSDO`	Write Object Dictionary. *Do not use unless you receive further instructions*	
`RPDO`	Rotate: Emulate reception of a PDO (i.e. command) from the acquisition PC *Do not use unless you receive further instructions*	Linear: Not valid for linear controller
`TPDO`	Rotate: Force transmission of a PDO (i.e. status message) to the acquisition PC *Do not use unless you receive further instructions*	Linear: Not valid for linear controller
`CSDO`	With this command, you can read/write the object dictionary from one motion controller to the other. This is a fast way to verify whether the CANbus connection between the two controllers is OK. If you get the reply: `Error on SDO request - errval = 0x55555555` there is no CANbus contact. *Do not use unless you receive further instructions*	
`GETNODEID`	Returns the switch setting for NodeID (CANbus address). Must be 35 for linear controller and 36 for rotate controller	
`STATUS`	Rotate: Returns status words for all axes plus the actual type of motion	Linear: Returns status words for the X- and Y-axis
`STOP`	Rotate: Stops the rotation axis.	Linear: Stops the X- and Y-axis
`ERRLOG`	Described in the section *Logging* on page 5-30	
`S, SETPIN`	Set output port pin high – `setpin 3` sets OUT03 high. *Do not use unless you receive further instructions*	
`C, CLRPIN`	Set output port pin low – `clrpin 3` sets OUT03 low. *Do not use unless you receive further instructions*	
`EXERCISE`	Activate the built-in single-axis exerciser. *Do not use unless you receive further instructions*	
`RALPHA`	Rotate: Display the position as (radius, angle) relative to the present center of rotation	Linear: Not valid for linear controller

<table>
<tr><th>Command</th><th>Rotate controller</th><th>Linear controller</th></tr>
<tr><td><code>RA</code></td><td colspan="2">Query the Runaway status for the actual motion controller. Valid for both motion controllers as each one individually may activate a Runaway output which removes motor power.
If Runaway is not active, the response will be:

No runaway, mask = 0x8467

(the value for ‘mask’ differs for the two motion controllers and may also differ for different software versions).
If Runaway is active, the response will comprise a cause code:

RUNAWAY, cause code = 0x0020, mask = 0x8467

The cause code is bitmapped, i.e. there may be more than one cause present at the same time. The interpretations of the individual bits are:
<table>
<tr><td>RA_X_ENC_ERROR</td><td>0x0001</td><td>The position readings from the absolute and the incremental encoders for the X axis differ too much</td></tr>
<tr><td>RA_Y_ENC_ERROR</td><td>0x0002</td><td>Same for the Y axis</td></tr>
<tr><td>RA_Z_ENC_ERROR</td><td>0x0004</td><td>Same for the Z axis</td></tr>
<tr><td>RA_LOST_SYNC_ ERROR</td><td>0x0020</td><td>Checksum error on 3 consecutive messages on the serial link used for communication between the two motion controllers. Happens if one of the motion controllers stops responding</td></tr>
<tr><td>RA_TIMEOUT</td><td>0x0040</td><td>The linear controller has not received synchronization messages from the rotate controller at the required regular interval</td></tr>
<tr><td>RA_X_ILL_MOVE</td><td>0x0100</td><td>The X axis has moved when it is not expected to</td></tr>
<tr><td>RA_Y_ILL_MOVE</td><td>0x0200</td><td>Same for the Y axis</td></tr>
<tr><td>RA_Z_ILL_MOVE</td><td>0x0400</td><td>Same for the Z axis</td></tr>
<tr><td>RA_TRAP</td><td>0x4000</td><td>The micro controller has encounterd an illegal instruction</td></tr>
</table></td></tr>
<tr><td><code>VERSION</code></td><td colspan="2">Print the boot message including software version (see the section Boot prompt on page 5-28)</td></tr>
<tr><td><code>SSCTX</code></td><td colspan="2">Transmit a message on the high-speed serial link used for communication between the two controllers.
Do not use unless you receive further instructions</td></tr>
<tr><td><code>BAUD</code></td><td colspan="2">Change the baud rate of the interface. Remember to change the terminal baud rate immediately afterwards</td></tr>
<tr><td><code>HELP, ?</code></td><td colspan="2">Print list of commands</td></tr>
</table>

5.6.2 EDC Module Diagnostics

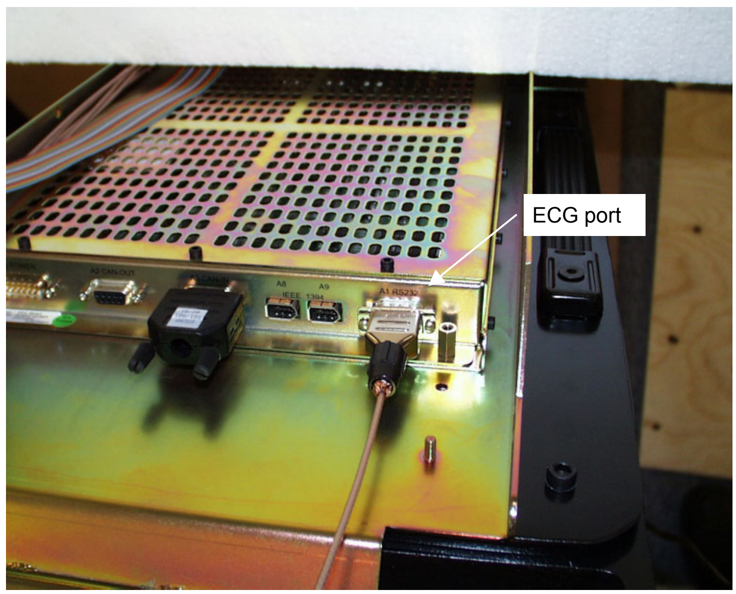
The EDC board has a serial port that can be used for troubleshooting purposes using various utilities resident within the EDC firmware. This section identifies only a few commands that may be helpful in troubleshooting CardioMD system related failures.

5.6.2.1 Tools Required

III

- NULL modem serial interface cable (DB9-female to DB9-female)
- When using a laptop acquisition PC (CardioMD Series III): An USB to RS 232 adapter, part no. 3ACQ1669.

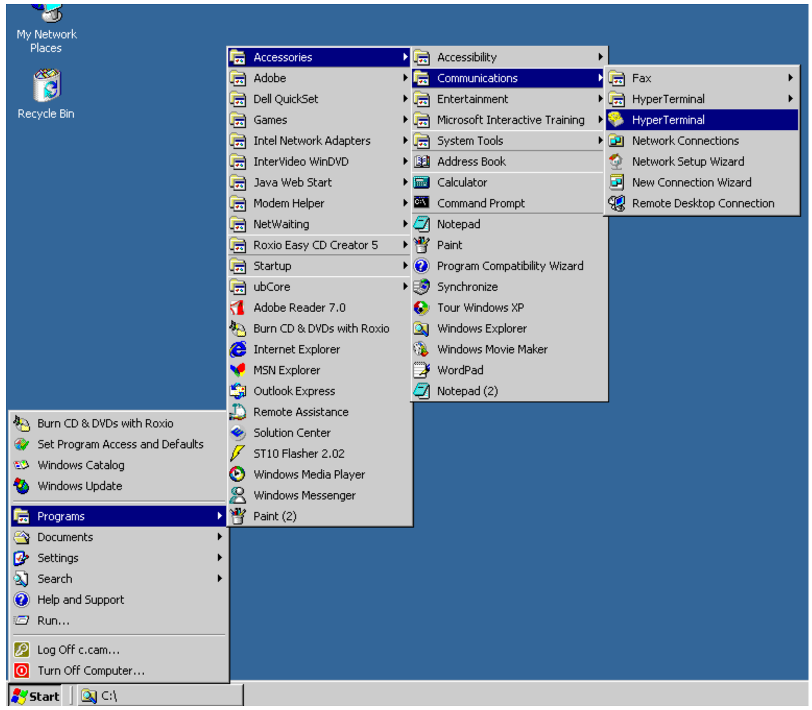
5.6.2.2 Configuring HyperTerminal for Terminal Access to EDC Module

Procedure	***Details***
Note. To communicate with the EDC module, you need a NULL modem serial interface cable (DB9-female to DB9-female). 1. Connect one end of the serial interface cable to the EDC ECG port labeled A1 RS232. This requires that the ECG cable be removed.	
With a laptop acquisition PC (CardioMD Series III): 2. Use the USB to RS 232 adapter to connect the opposite end of the serial interface cable to one of the acquisition PC's USB ports.	III
With a tower acquisition PC (CardioMD Series I and II): 3. Connect the opposite end of the cable to the COM1 serial port on the CardioMD Acquisition PC.	I, II

Procedure	***Details***

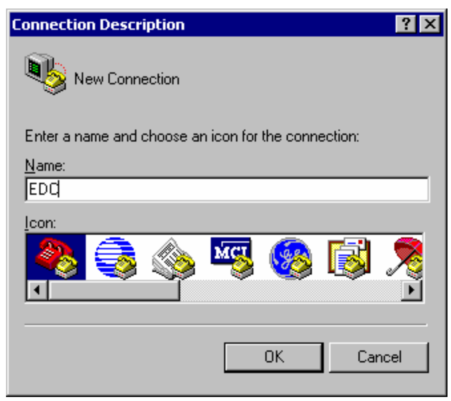
4. In the Windows Start menu, select **Programs**, **Accessories**, **Communications** and **HyperTerminal**.

Note. The screen pictures shown on this page are from a Windows XP installation. However, the Windows 2000 user interface is very similar to these.



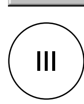
HyperTerminal displays the connection Description window.

5. In the Name field, enter EDC, and select OK.



HyperTerminal displays the Connect To dialog.

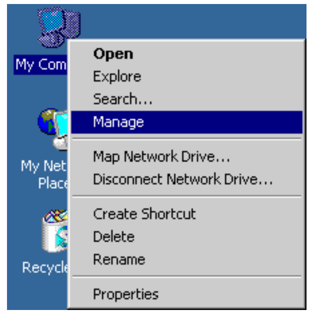
When using a laptop acquisition PC, you may need to check which COM port the USB to RS 232 adapter uses:



Procedure	*Details*

6. On the acquisition PC's desktop, right-click the My Computer icon and select Manage from the pop-up menu.

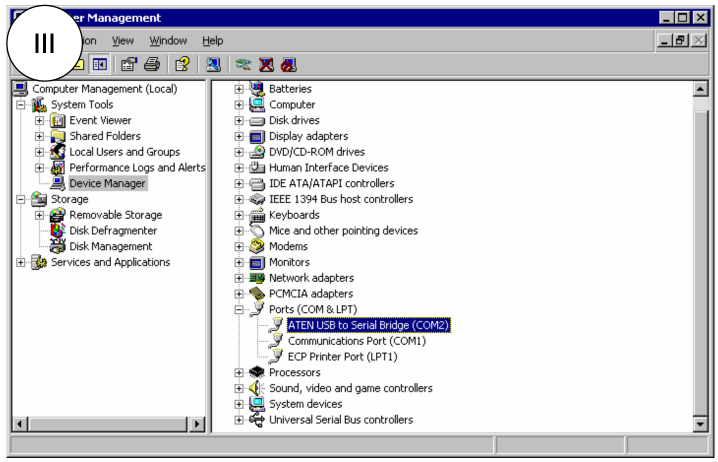
III



The Computer Management window appears.

7. In the left-hand pane, select Device Manager.
8. In the right-hand pane, click the + next to the entry Ports (Com & LPT).
9. Check the COM port number stated next to the item ATEN to USB Serial Bridge.

III



On a tower acquisition PC, you must use COM1.

I, II

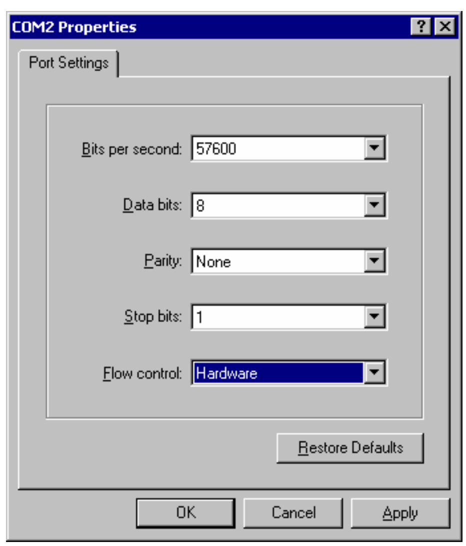
10. Ensure that the correct COM port is selected.

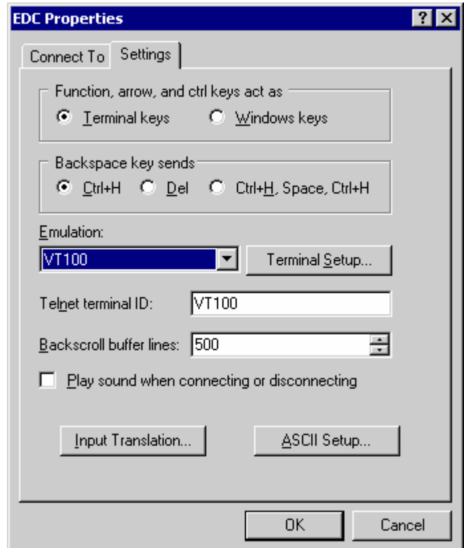
I, II   III

11. Click OK to continue.

The COM Properties dialog appears.

12. Set the following parameters for the serial interface:
    Baud rate: 57 600
    Data bits: 8
    Parity: None
    Stop bits: 1
    Flow control: Hardware.
13. Click OK to continue.



Procedure	*Details*
The HyperTerminal main window appears. 14. In the menu bar, select **File**, **Properties**. The EDC Properties dialog appears. 15. Select the Settings tab. 16. In the Emulation drop-down list, select VT100 and click OK. HyperTerminal is now ready to communicate with the EDC board. To make the motion controller display its `->` prompt in the HyperTerminal main window: 17. Press [Enter]. 18. This should cause the EDC prompt to appear. 19. For further details, see section 5.6.2.3.	

5.6.2.3 CardioMD EDC Command Definitions

The commands listed below are only accessible via the EDC board's serial port labeled A1 RS232. These commands can be useful when diagnosing system failures and intermittencies.

Note. The EDC interface only accepts numerical parameter(s) to commands. Parameters can be entered either as decimal or hexadecimal values. Parameters shown in brackets {…} are optional.

Command List

`?` — A help command that displays and provides a brief explanation of available commands and utilities. It is useful when attempting to recall a specific command and associated command flags.

Example:

```
?
STATUS Print status information
RDB    Read byte from memory {Address}

   ...
VERSION          Print version information
HELP, ?          Print list of commands
```

`Version` — Print the software version. The hardware part number printed with the same command is just a comment and does not reflect the actual hardware revision.

Example:

```
-> VERSION

EDC Board
Hardware version 9EDC0654-B05
Software version 7CTL0079-A00-b3
Compile time     Dec  1 2000 - 09:51:20
```

`-hv {value}` Set high voltage to specified value. If no value is specified, the actual high-voltage setting is printed. This is useful when troubleshooting techniques require the detector high voltage to be changed. The alternative method is to edit the `hvcal.dat` file on the acquisition PC and load tables.

Example:

```
-> hv
High Voltage = 1200 V
```

or

```
-> hv 1200
High Voltage = 1200 V
```

`-pmt {number} {value}` Set PMT gain value. If number is zero, all PMTs will be set to the same value. If no value is specified, the current gain setting will be printed. This is useful when attempting to manually change a specific PMT gain value or print the current loaded values.

Example:

```
-> PMT

PMT gain:
 1:947  424  533  402  560  525
 7:648  374  334  281  180  346
13:380  211  383  525  377  298
19:233  350  273  233  206  537
```

`-wp` Print PMT work points. This is useful to determine if PMT gains are under control. All 24 WP numbers must be in the range 20 to 150.

Example:

```
-> WP

PMT Workpoints
  1:  70  82  83  76  71  65
  7:  72  66  76  90  72  83
 13:  63  86  77 109  66  81
 19:  71  57  77  97  72  76
```

Note. When reading the PMT workpoints, the order of the row number (1, 7, 13, 19) is reversed.

`-dyncor {selector} {value}` Set the selected DYNCOR value. If no value is specified, the current values will be printed. Do the printing to see which selector to use. This is useful to determine if the DYNCOR calibration file is properly loaded.

Example:

```
-> DYNCOR

Dyncor: 0:HiDyn = 300, 1:LoDyn = 160, 2:Thresh =
400
```

`-event {value}` Enable/disable event transmission to the PC. The following values apply:
0: Disable event transmission.
1: Send uncorrected events.
2: Send energy corrected events.
3: Send linearity corrected events.
4: Send energy and linearity corrected events.

On power-up and reset, the correction tables are initialized with zeros, which is equivalent to 'uncorrected'.

This is a useful utility when troubleshooting detector performance problems. This utility allows for specific corrections to be loaded when acquiring an acquisition to determine if a failure is in the correction table or detector.

Example:

```
Event 1
```

Note. Remember to execute this command after the tables have been loaded when accessing an acquisition screen.

`Time` Identifies the time from when the EDC board (system) was last reset.

Example:

```
-> TIME
System time is 404658 seconds since reset
```

`ERRLOG` Using the logging facility it is possible to get information with various degrees of details. Default setting is all logging off.

Example:

```
< errlog 0x1000 > = CanBus communication
< errlog 0x2000 > = CanBus HW errors
< errlog 0x4000 > =  FireWire input
```

The logging setting is the result of an OR operation performed on these individual hexadecimal values. For example, spcrifying `errlog 0x7000` enabes logging of CanBus communication, CanBus HW errors and FireWire input.

5.6.3 FireViewer

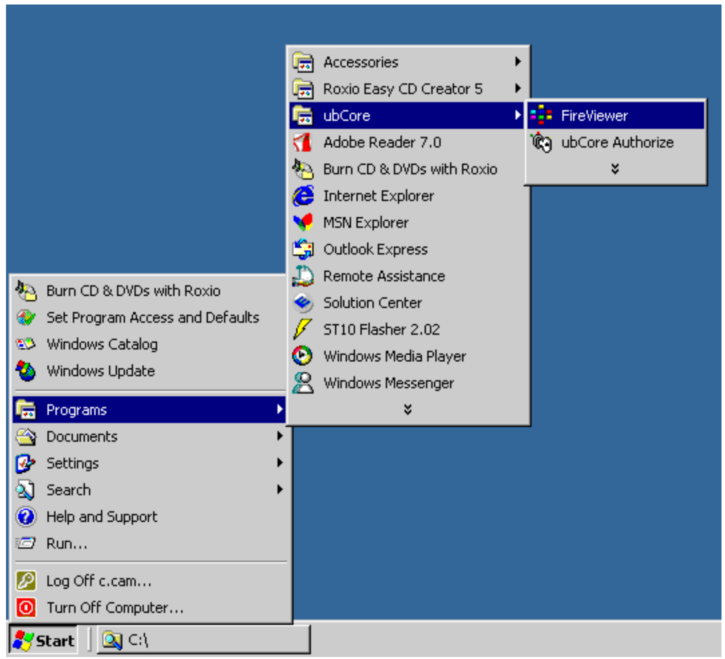
This program is part of the FireWire driver installation on the acquisition PC. The program enables you to perform a quick check of the integrity of the FireWire communication.

Procedure	***Details***

To access the program:

1. Click the Windows Start button, and then select **Program**, **ubCore**, **FireViewer**.

The FireViewer program is located in the directory `c:\Program Files\Unibrain\ubCore`.



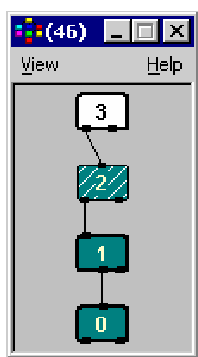
When the FireViewer program has been started, it immediately shows the status of the communication.

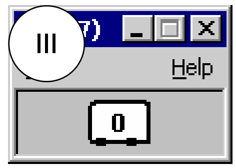
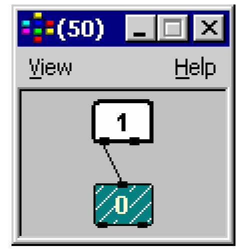
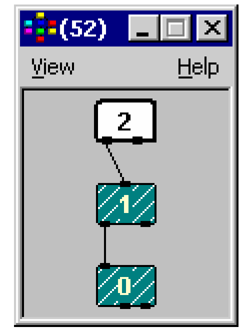
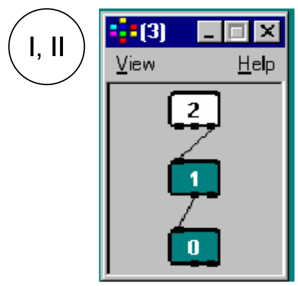
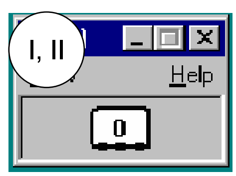
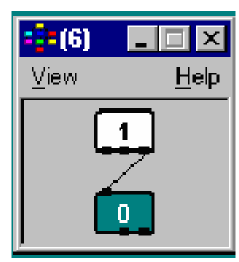
In CardioMD Series III systems, the FireWire comprises four nodes:

- The controlling node, i.e. the acquisition PC, shown as a white box
- The FireWire hub shown as a hatched box (normal operation)
- The two regular nodes, i.e. the two detector EDC modules, shown as green boxes.

The FireViewer window shown in the example indicates normal communication.

III



Procedure	*Details*
If one of the nodes is missing, it indicates a problem. The three examples on the right (Series III systems) illustrate the possible locations of problems.	 Between acquisition PC and FireWire hub  Between FireWire hub and detector 2 EDC board  Between the two EDC modules
In CardioMD Series I and II systems, the FireWire comprises three nodes: • The controlling node, i.e. the acquisition PC, shown as a white box • The two regular nodes, i.e. the two detector EDC modules, shown as green boxes. The FireViewer window shown in the example indicates normal communication.	
If one of the two green nodes is missing, it indicates a problem. The two examples on the right illustrate the possible locations of problems.	 Between acquisition PC and detector 2 EDC board  Between the two EDC modules

5.6.4 Acquisition PC Error Logs

The log file information recorded on the CardioMD acquisition PC is a useful tool for diagnosing system failures and intermittencies. Technical support personnel may request that copies of these files be provided in an effort to better diagnose system problem. The information presented in this section is for reference only. Detailed information regarding the contents of these files is not provided.

5.6.4.1 System Log Directory

Every time the CardioMD application is started, a new log file is created in the directory `\Cardiocam\SystemLog`. The name of the log file is, for example:

```
Log{May 28 2004 - 11.04.07}.txt
```

Thus, each log file has a unique name indicating which log file is most recent. It is also possible to find old log files related to a specific date and time.

5.6.5 Determining the Cause of a Runaway Condition

When a Runaway condition exists, all the following symptoms are present:

1. A Fatal Runaway Error pop-up message is displayed on the acquisition PC.
2. No manual or preprogrammed motions are possible.
3. The yellow Collision Override LED on the hand controller is ON and cannot be turned off by pressing the hand controller Collision Override button.
4. The green motor power LED on the gantry connector panel or the LED panel next to the acuqisition PC is off.

Fatal runaway errors can be caused by one or more of the following:

1. The motion controllers detect conflicting position information from the incremental encoder and absolute encoder on one or more of the motion axes (horizontal (X), vertical (Y), rotate (Z)).
2. Actual motion runaway, that is, an un-requested motion has been detected.

Note. An actual motion runaway detected on the X and Y axis is not reported to the acquisition PC but is only indicated by the red Runaway LED on the safety board. One example of this is when the crank is used for emergency Y-motion retraction.

3. The two motion controllers (located in the table console) are unable to communicate with each other.

The most likely cause for the runaway condition is that the motion controllers are detecting different position information from the two position encoders (cause 1).

The most likely reasons for this are:

- A defective absolute encoder, cable, or connector.
- An absolute encoder gear has come loose from the encoder shaft.
- A defective safety board.

The first thing to determine is which of the axes (motions) is causing the runaway error. To do this, examine the system log file as follows:

1. On the Acquisition PC, ensure that the CardioMD application is displaying the Persistence page.
2. Click the  button in the rupper right-hand corner of the application window to close down the CardioMD application.
3. In the Windows Start menu, select **Programs**, **Accessories**, **Notepad**.
4. In Notepad, select **File**, **Open**.
5. Select the file `C:\cardiocam\SystemLog\log{“last date”}.txt.`

Note. Every time the CardioMD application is started, a new log file is created.

A runaway caused by a faulty absolute encoder will appear in the log file. An example is shown below:

```
Motion Status: Ack = 0xFFFF, Error = 0x0010, X = 0x00, Y = 0x00, Z
= 0x01
[22.33.15] Motion controller error: Runaway
```

The error codes are bitmapped individually for each axis. The 0x01 bit is the encoder position discrepancy. Thus the message above indicates a runaway being caused by an encoder error in the Z-axis (rotate).

Following a runaway error, each axis will assert the 0x02 bit because motor power is lost (removed by the safety board via the motion controller(s)). As the axes are not scanned simultaneously, these bits will occur in an arbitrary sequence and may cause multiple entries in the log file. An example is given below:

```
Motion Status: Ack = 0xFFFF, Error = 0x0010, X = 0x00, Y = 0x01, Z
= 0x00
[21.18.17] Motion controller error: Runaway
Motion Status: Ack = 0xFFFF, Error = 0x8011, X = 0x00, Y = 0x03, Z
= 0x02
[21.18.17] Motion controller error: Runaway
Motion Status: Ack = 0xFFFF, Error = 0x8011, X = 0x02, Y = 0x03, Z
= 0x02
[21.18.17] Motion controller error: Runaway
```

First, the Y-axis encounters an error (`Y = 0x01`). Then the motion controller actually asserts the runaway output signal to the safety board, which then removes motor power. Subsequently, this is detected by the individual axis, which asserts the motor power lost bit. In the above example, the Y-axis is first to show the discrepancy followed by the Z-axis and then the X-axis.

If all three axes are reporting a runaway condition, the most likely cause is a defective safety board. To correct this problem, the safety board must be replaced.

If a single axis is failing, the most likely cause is a defective absolute encoder or a loose absolute encoder gear.

Having identified the axis causing the runaway, the next thing to do is to ensure that the gear on the absolute encoder is secured on the encoder shaft and is properly engaged with the worm gear. Check for backlash by carefully trying to rotate the nylon worm gear. There must be *no* backlash. If backlash is seen, tighten the screws holding the nylon worm wheel on the encoder shaft, and tighten the three screws holding the bracket with the absolute encoder assembly. Recalibrate the axis following the procedure given in Chapter 4 *Calibration*, the section *Motion Calibration*.

If no backlash is observed, the problem is most likely caused by a defective absolute encoder, cable, or connector. To solve the problem, the absolute encoder and cable must be replaced. After replacement of the encoder and cable, the axis must be calibrated following the procedure given in Chapter 4 *Calibration*, the section *Motion Calibration*.

5.7 Importing and Exporting Study Files

The CardioMD acquisition PC has a feature allowing study files to be exported from the patient database to a folder and to be imported from the folder into the database of another CardioMD acquisition PC.

This section describes the steps involved in exporting and importing from a folder.

5.7.1 Exporting Study Files to a Folder

Procedure / ***Details***

If the CardioMD application is running, close it down:

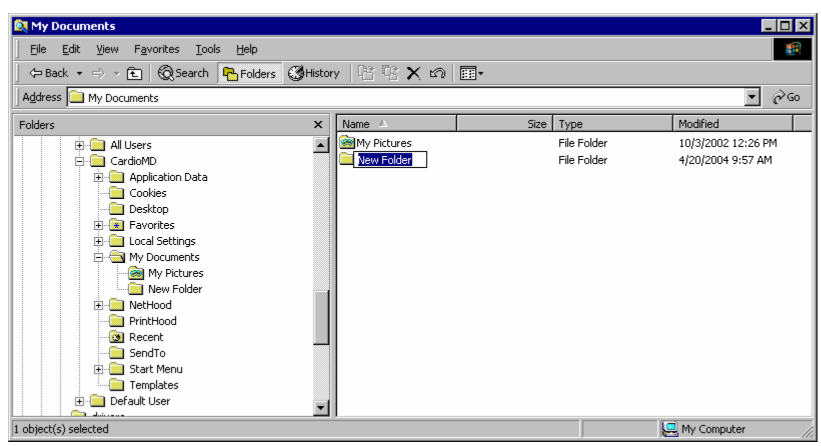
1. On the acquisition PC, ensure that the CardioMD application is displaying the Persistence page.
2. Click the Close button in the upper right corner of the application window to close down the application.

Start the Windows Explorer:

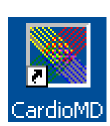
3. Right-click the Windows Start button and select **Explore** from the pop-up menu.

Create the directory to where the study files are to be exported:

4. In Folders pane, select an appropriate directory.
5. Right-click in the right-hand pane and select **New**, **Folder** from the pop-up menu.
6. Enter the desired directory name, and press [Enter].

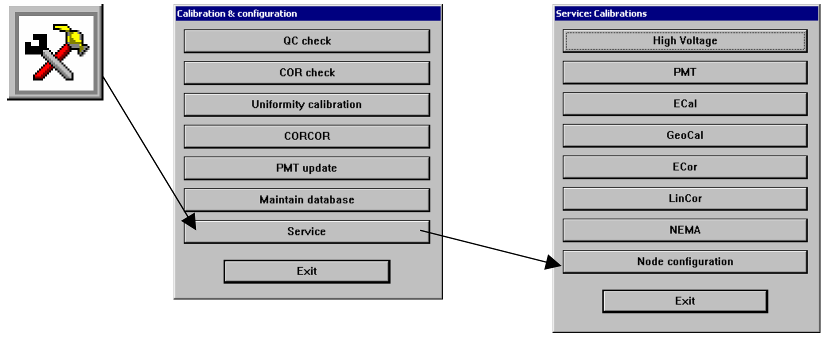


7. Click the Close button in the upper right corner of the Explorer window to close down Explorer.
8. Double-click the CardioMD icon on the desktop to start the CardioMD application.

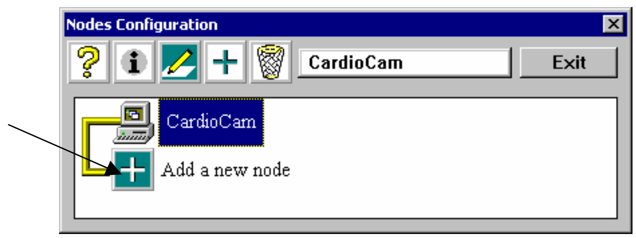


Procedure	***Details***

9. On the Persistence page, click the Tools button.
10. When the Calibration & Configuration menu appears, click Service.
11. If prompted, enter the service password (currently DDD).
12. In the Service Calibrations menu, click Node configuration.

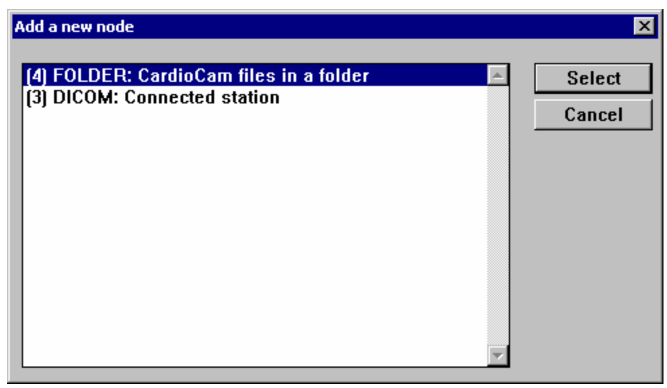


13. In the Nodes Configuration dialog, double-click the + to add a new node.



The Add a new node dialog appears.

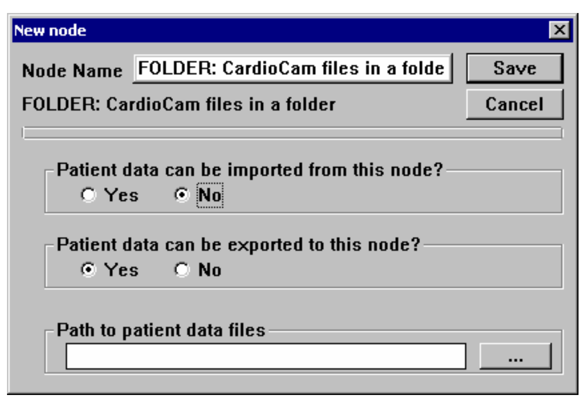
14. Select the FOLDER option and click Select.

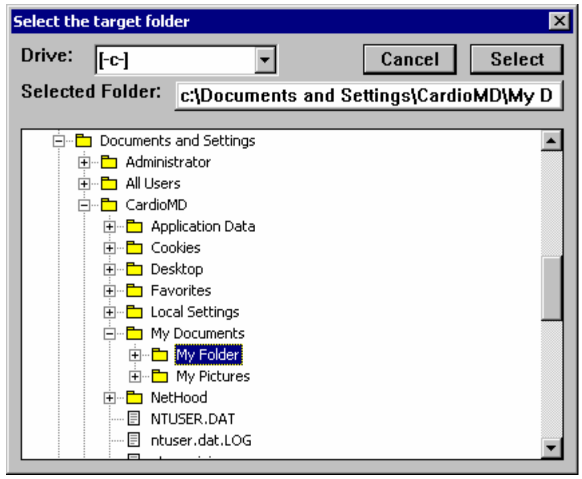
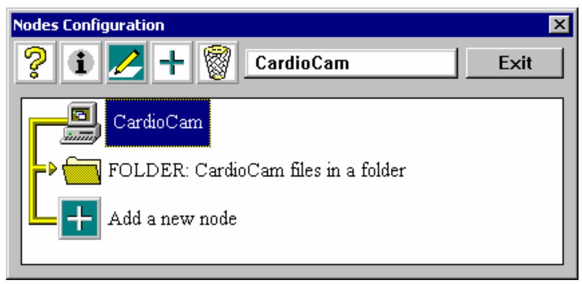
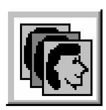
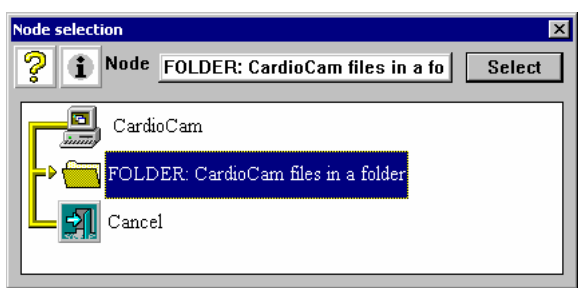


15. Check off import/export capabilities from the node as shown: Yes to Export and No to Import.

Note. If you want to both import and export from the node, check off Yes in both selections.

16. To select the folder to where files will be exported, click the … button.

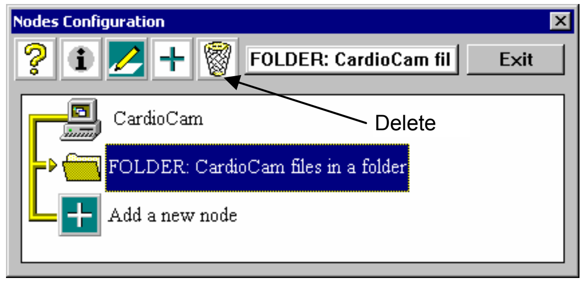


Procedure	***Details***
17. Click on the folder that you just created and click Select.	
The New Node dialog reappears.	
18. Click Save.	
A new item appears in the Nodes Configuration list.	
19. Click Exit.	
20. On the Persistence page, click the Patient Database button.	
21. On the Patient Database page, select the study or studies to be exported.	
Instructions are provided in Chapter 4 *Operating Instructions* of the CardioMD Operator's Manual.	
22. Click Export.	
23. Click the FOLDER entry and click Select to export the selected study or studies to the folder.	
24. Click Done to exit the Patient Database page.	
When done with the export operation, it is important to delete the folder node:	
25. Proceed as explained in step 9 – 12 to	

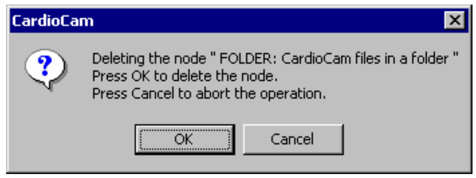
Procedure	Details

display the Nodes Configuration dialog.

26. Select the Folder entry and click the Delete button.



27. When prompted to confirm the delete operation, click OK.
28. Click Exit.
29. Close down and then re-start the CardioMD application to disable the service password.



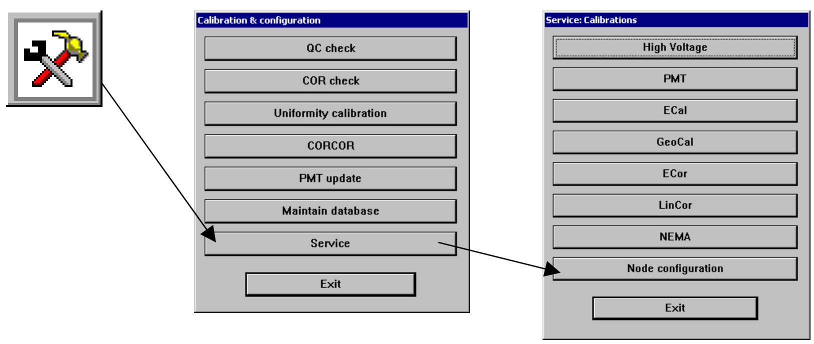
The exported study files are now accessible in the created folder.

5.7.2 Importing Study Files from a Folder

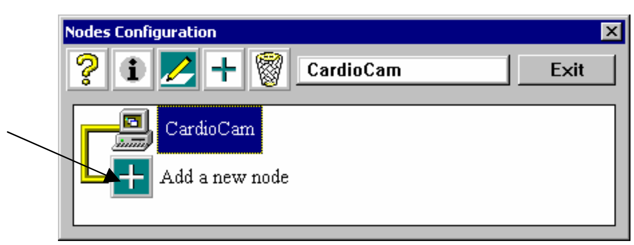
Study files can be imported into the CardioMD Patient Database from a directory on the acquisition PC's hard disk, from a CD-ROM or from a floppy disk. In the following procedure, it is assumed that the study files are placed in a directory on of these media.

Procedure	Details

1. Ensure that the CardioMD application is displaying the Persistence page.
2. Click the Tools button.
3. When the Calibration & Configuration menu appears, click Service.
4. If prompted, enter the service password (currently DDD).
5. In the Service Calibrations menu, click Node configuration.



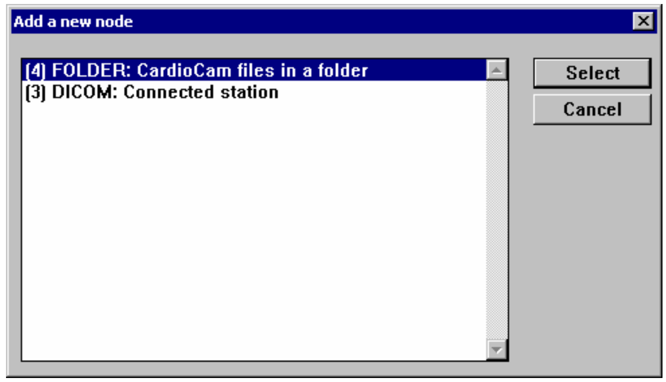
6. In the Nodes Configuration dialog, double-click the + to add a new node.



Procedure	***Details***

The Add a new node dialog appears.

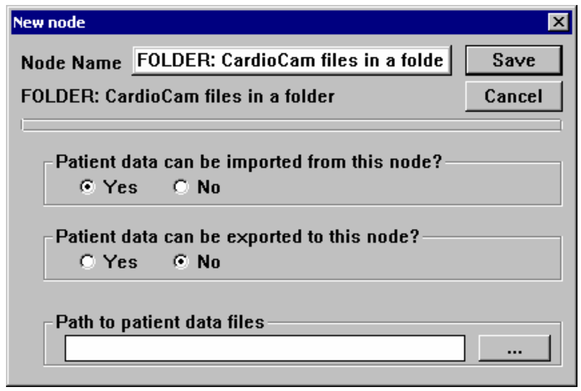
7. Select the FOLDER option and click Select.



8. Check off import/export capabilities from the node as shown: No to Export and Yes to Import.

Note. If you want to both import and export from the node check of Yes in both selections.

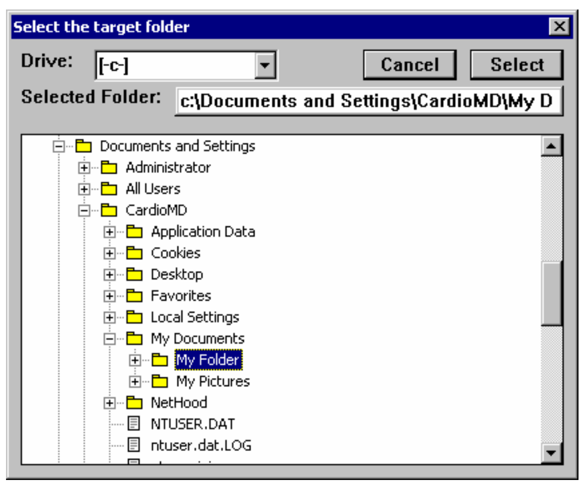
9. To select the folder from where files will be imported, click the … button.



10. Ín the Drive drop-down, select the drive where the folder containing the study files is located.

The contents of the drive appear in the large pane.

11. Click on the folder's name and click Select.

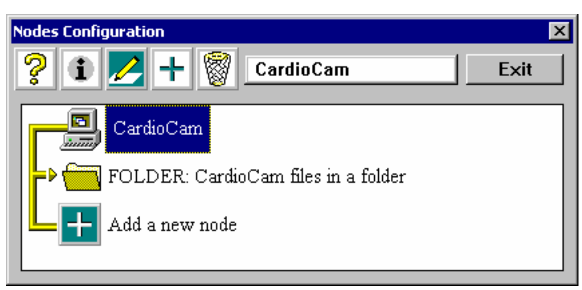


The New Node dialog reappears.

12. Click Save.

A new item appears in the Nodes Configuration list.

13. Click Exit.



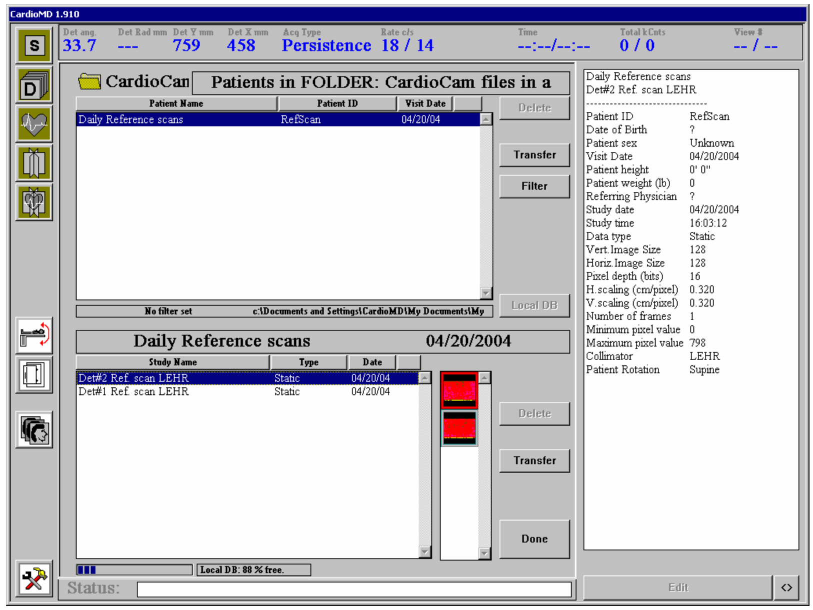
Procedure	***Details***

14. When the Persistence page reappears, press [F3].

15. The CardioMD application displays the study files stored in the folder you have just set up.

16. Select either the patient (uppermost list) or the study/studies to be imported and click Transfer.

More detailed operating instructions can be found in the CardioMD Operator's Manual, Chapter 4 *Operating Instructions*. See the sections *Exporting a Patient* and *Exporting a Study*.



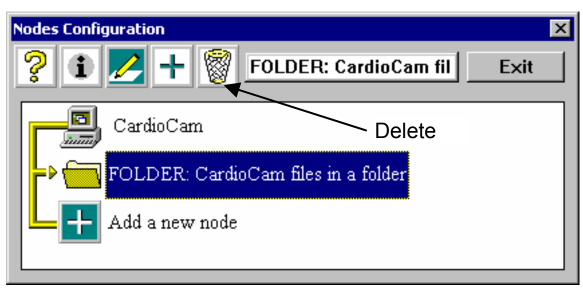
17. When the data transfer is complete, click Done to return to Persistence page.

The study files have been imported into the patient database.

When done with the import operation, it is important to delete the folder node:

18. Proceed as explained in step 1 – 5 to display the Nodes Configuration dialog.

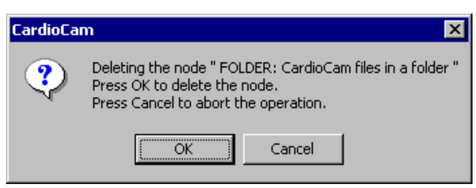
19. Select the Folder entry and click the Delete button.



20. When prompted to confirm the delete operation, click OK.

21. Click Exit.

22. Close down and then re-start the CardioMD application to disable the service password.



5.8 Setting Up FTP and Telnet

This section explains how to set up FTP and Telnet on the CardioMD acquisition PC. When installed, these components allow remote access to the acquisition PC and transfer of e.g. log files from the acquisition PC to a remote site. This can be a help in diagnosing fault conditions on the CardioMD system.

5.8.1 Windows 2000

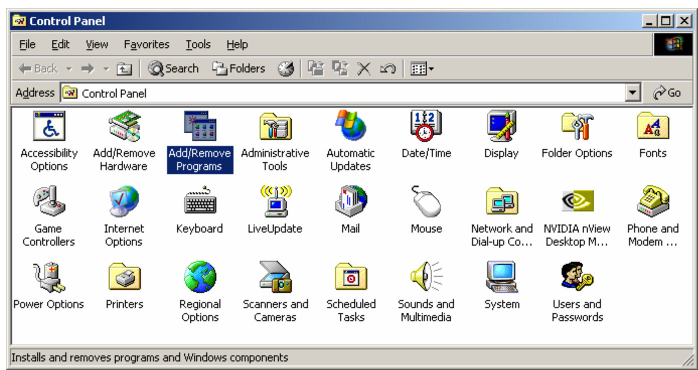
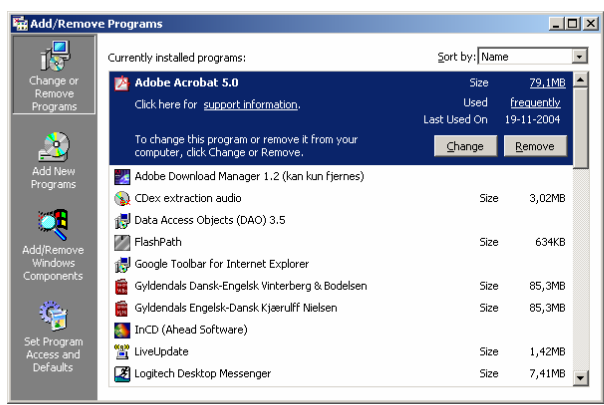
I, II

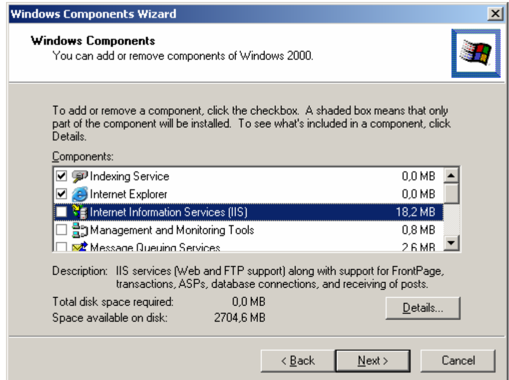
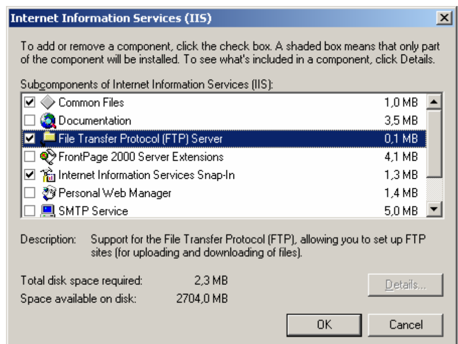
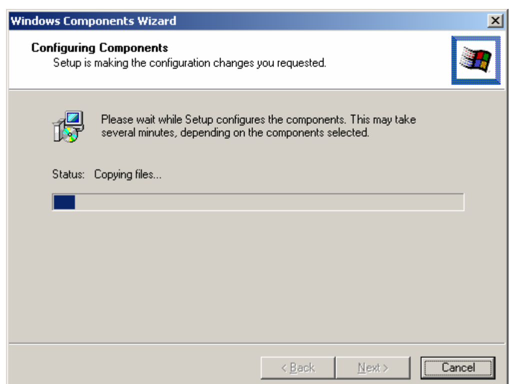
If the acquisition PC is running Windows 2000, you need to install FTP software as described in the procedure below.

5.8.1.1 Tools Required

- Windows 2000 Installation CD.

5.8.1.2 Creating and Setting Up a FTP Server

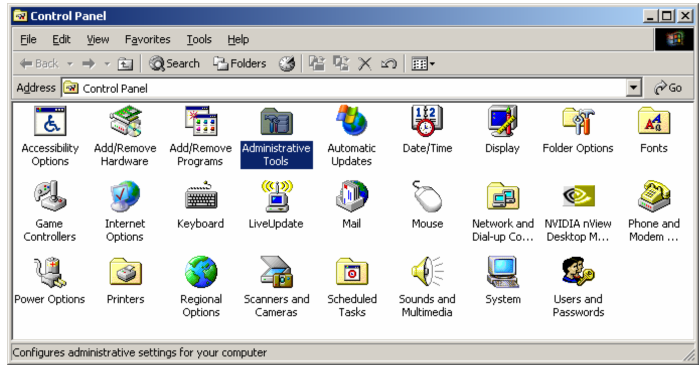
Procedure	*Details*
1. In the Windows Start menu, select **Settings**, **Control Panel**.	
2. In the Windows Control Panel, double-click Add/Remove Programs.	
3. In the Add/Remove Programs dialog, select Add/Remove Windows Components. The Windows Components Wizard starts up.	

Procedure	***Details***
4. Select Internet Information Services (IIS). 5. Click Details.	
6. Check the entry File Transfer Protocol (FTP) Server. 7. Click OK.	
A progress indicator appears. 8. When prompted, insert the Windows 2000 installation CD in the CD-ROM drive and click OK. The system proceeds to install and configure the FTP server.	
When the installation is complete: 9. Click Finish to exit the wizard.	

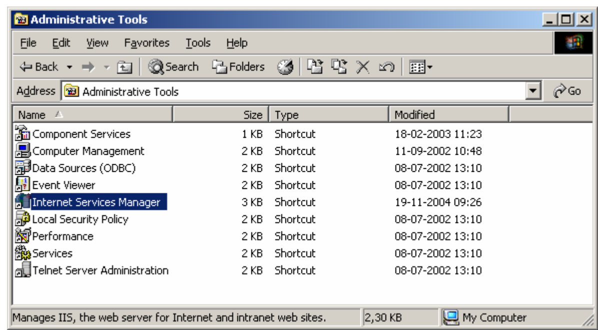
Procedure	***Details***

10. Close the Add/Remove Programs dialog by clicking the Close button in the upper right-hand corner of the window.

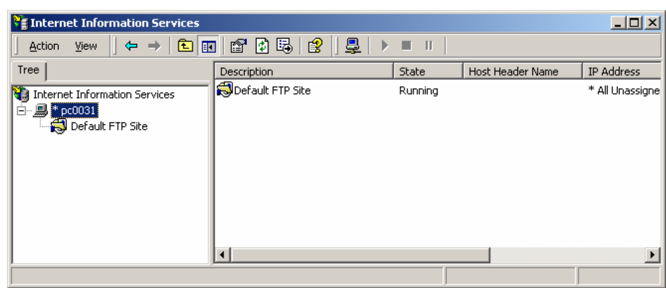
11. In the Control Panel, double-click Administrative Tools.



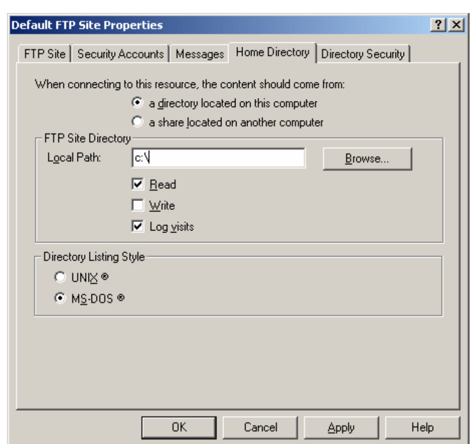
12. In the Administrative Tools window, double-click Internet Services Manager.



13. In the Internet Information Services window, click the + next to the name of the computer to unfold the branch of the tree.
14. Right-click Default FTP Site and select Properties from the drop-down menu.



15. In the Default FTP Site Properties dialog, select the Home Directory tab at the top of the window.
16. On the Home Directory page, set Local Path to `C:\`.
17. Click OK.



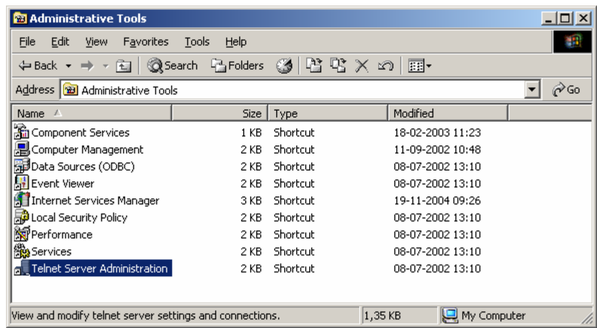
Procedure	*Details*
18. Close the Internet Information Services window.	
19. Leave the Administrative Tools window and the Control panel open.	

5.8.1.3 Setting Up Telnet

In this procedure, you set up a Telnet server on the acquisition PC. When this is accomplished, a remote user can log into the acquisition PC via Telnet.

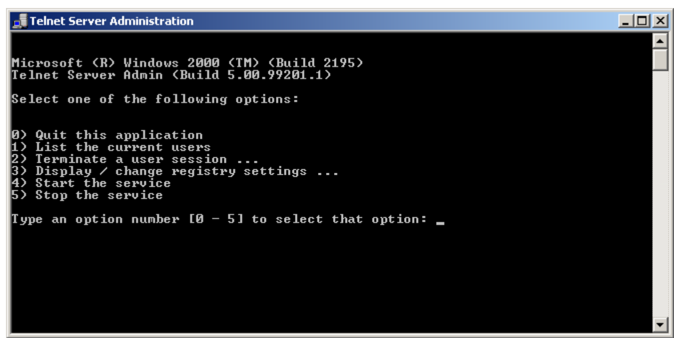
Procedure | *Details*

1. In the Administrative Tools window, double-click Telnet Server Administration.

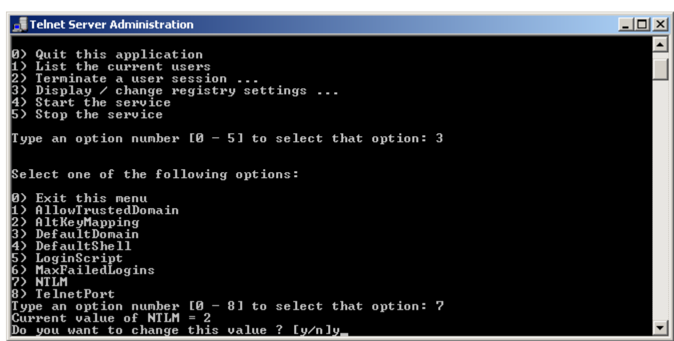


A command window appears.

2. Enter `3` [Enter] to Display/change registry settings.



3. Enter `7` [Enter] to select NTLM.
4. When prompted, enter `y` [Enter] to confirm.

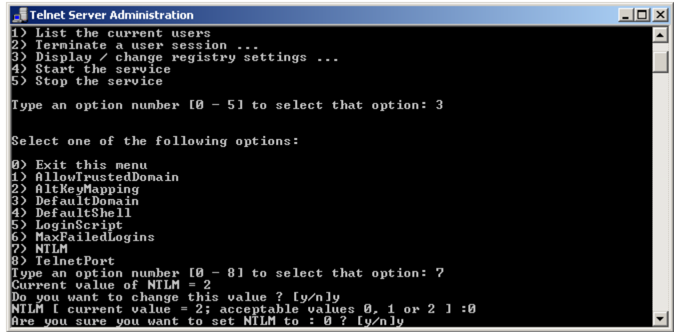


Procedure	*Details*

5. Enter the new value `0` [Enter].

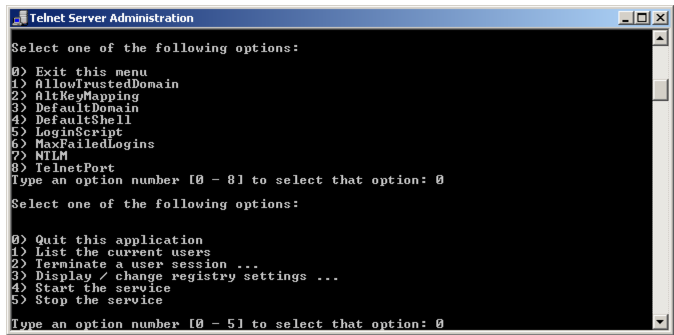
This setting disables NTLM.

6. When prompted, enter `y` [Enter] to confirm.

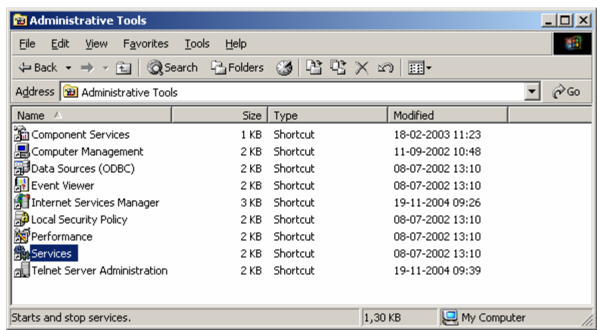


7. Enter `0` [Enter] to exit the menu.

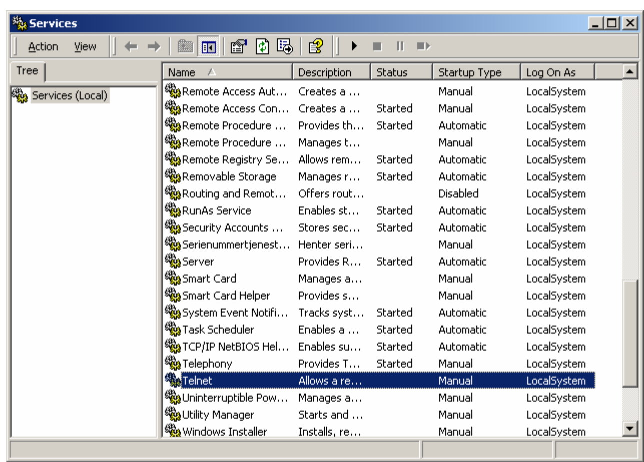
8. Enter `0` [Enter] to quit the application.



9. In the Administrative Tools window, double-click Services.



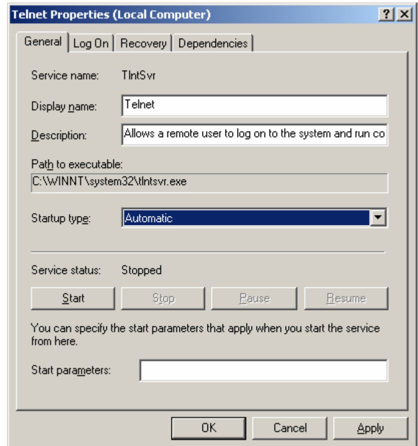
10. In the right-hand pane of the Services window, double-click Telnet.



Procedure	***Details***

11. In the Telnet Properties dialog, select Automatic from the drop-down list Startup type.
12. Click Apply.
13. Click Start.
14. Click OK.

The Telnet server is now set up and running on the acquisition PC.



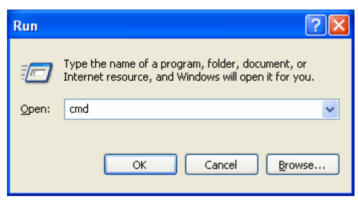
5.8.2 Windows XP

If your acquisition PC is running Windows XP, FTP and Telnet are already installed. All you need to do is to configure the Telnet server.

Procedure	***Details***

1. In the Windows Start menu, select **Run**.
2. In the Run dialog, enter `cmd` and click OK.

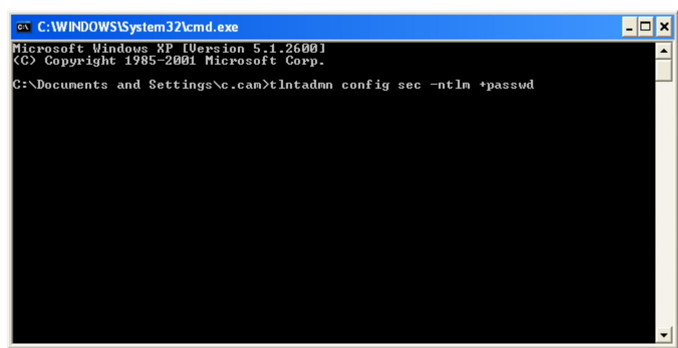
A command window appears.



3. At the > prompt, enter the command

   `tnltadmn config sec -ntlm +passwd [Enter]`.

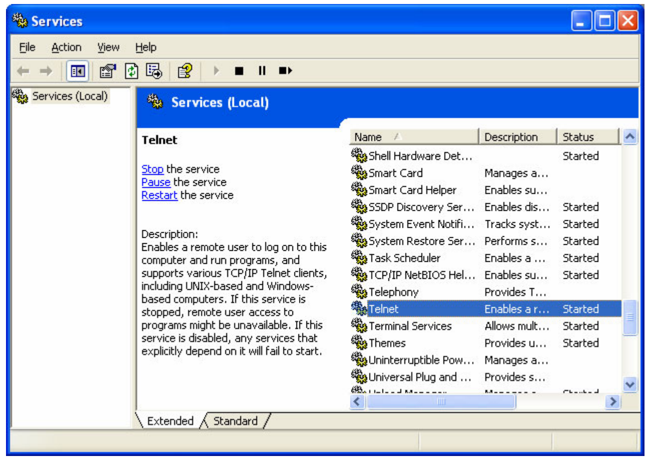
5. Click the Close button in the upper right corner of the window to close the command window.



6. In the Windows Start menu, select **Settings**, **Control Panel**, **Administrative Tools**, **Services**.

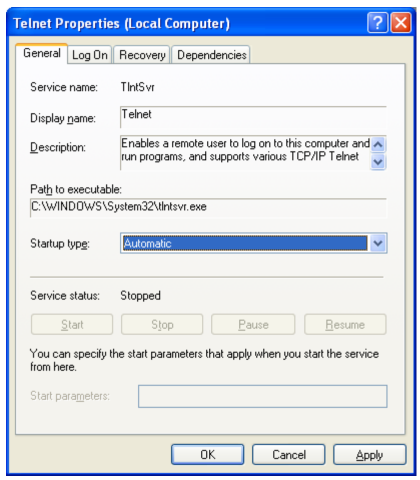
Procedure	***Details***

7. In the Services window, right-click Telnet in the right-hand pane.
8. Select Properties from the drop-down menu.



9. In the Telnet Properties dialog, select Automatic from the drop-down list Startup type.
10. Click Apply.
11. Click Start.
12. Click OK.

The Telnet server is now set up and running on the acquisition PC.



5.9 Remote Log On

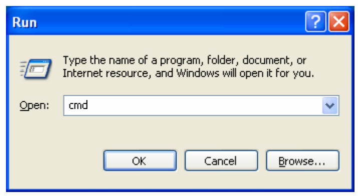
This section provides instructions for logging on to FTP and Telnet on the acquisition PC from a remote site.

5.9.1 FTP Logon

Procedure	*Details*

1. In the Windows Start menu, select **Run**.
2. In the Run dialog, enter `cmd` and click OK.

A command window appears.



3. At the > command prompt, enter the following command:

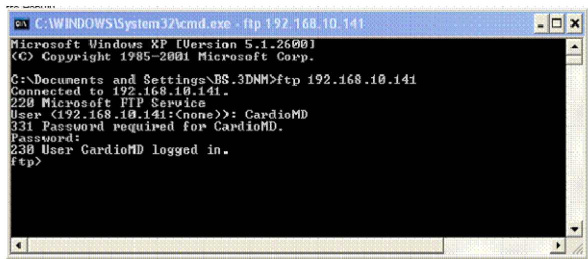
   `> ftp <IP-address>` [Enter]

4. When prompted for a user name, enter:

   `> CardioMD` [Enter]

5. When prompted for a password, enter:

   `> CardioMD` [Enter].



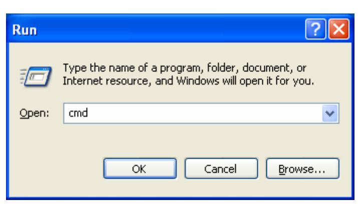
The `ftp>` prompt appears indicating that the acquisition PC is ready to receive ftp commands.

5.9.2 Telnet Logon

Procedure	*Details*

1. In the Windows Start menu, select **Run**.
2. In the Run dialog, enter `cmd` and click OK.

A command window appears.



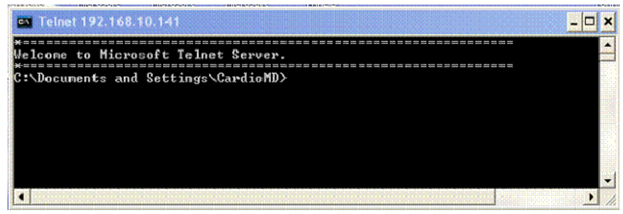
3. At the > command prompt, enter the following command:

   `> telnet <IP-address>` [Enter]

4. When prompted for a user name, enter:

   `> CardioMD` [Enter]

5. When prompted for a password, enter:

Procedure	***Details***
> `CardioMD` [Enter].	
The acquisition PC answers: Welcome to Microsoft Telnet Server. You can now enter DOS commands to operate the acquisition PC.	

5.10 Detector Calibration Files

The directory `C:/Cardiocam/Calibrations` stores five calibration files per detector. The files are in ASCII format and can be reviewed in Windows Notepad. The five files are:

- `dyncor.det#`
- `Ecal.det#`
- `Geocal.det#`
- `HVcal.dat`
- `PMTcal.det#`

where `#` is `1` for detector 1 and `2` for detector 2.

Figure 5.16 on page 5-59 shows typical values in the files together with a brief explanation.

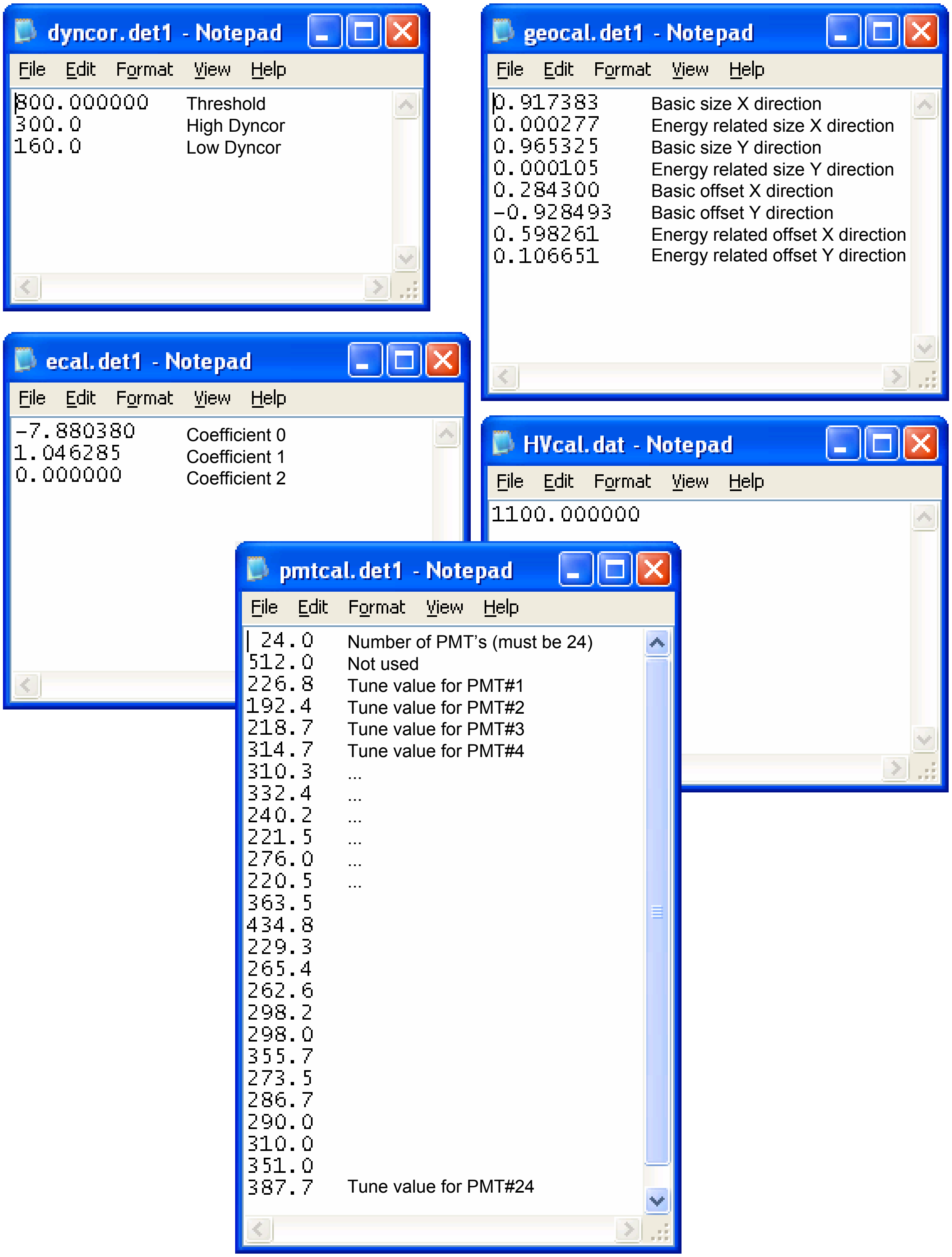


Figure 5.16 Detector calibration files

6 REPAIR PROCEDURES

Contents

6.1 Introduction

The general repair philosophy for the CardioMD is to repair at a Field Replaceable Unit (FRU) level.

The hardware indicators and software diagnostic utilities allow fault isolation to FRU level.

6.2 Gantry Repairs

6.2.1 General

Most parts of the CardioMD system are easily replaceable in the field. No written procedures are required for these. Some parts, however, require more comprehensive procedures to replace. Those procedures are described in the following sections.

WARNING

Some gantry components represent risks of serious injury if removed. Make sure that heavy parts are adequately supported or in balance during repairs on these.

WARNING

Disconnect power to the gantry before replacing any electrical parts. Not disconnecting power entails a risk of serious injury from electrical shock and may lead to damage of the electronic parts.

Connect anti-static wrist strap before replacing any electrical parts. Failing to use a wrist strap may lead to damage to electronic parts due to static discharge.

6.2.2 Tools

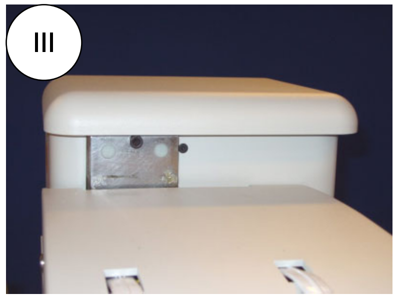
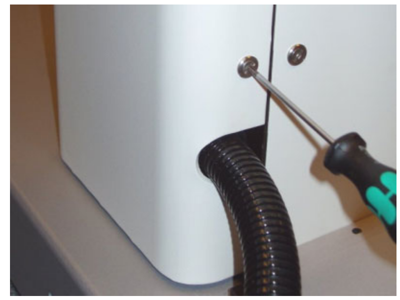
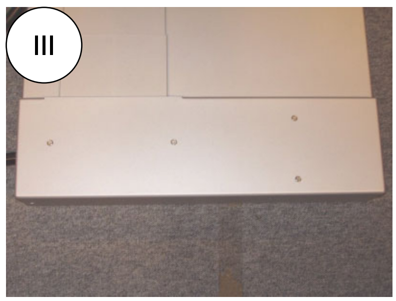
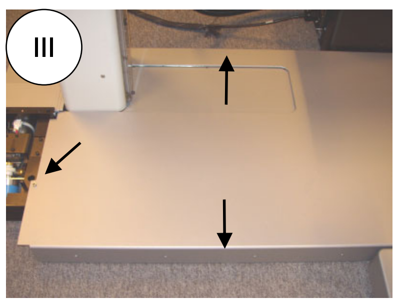
Tools needed for gantry repairs are:

- Metric Allen Keys 1.5 to 10 mm
- A 17 mm spanner
- A selection of standard and Phillips screwdrivers
- Assorted cable binders for re-cabling.

6.2.3 Removing Series III Base Cover

III

This section explains how to remove the gantry base cover of CardioMD Series III systems. Removing the base cover of older systems is straightforward.

Procedure	***Details***
On Series III systems: 1. Remove the top cover and outer cover from the gantry pillar.	 
2. Remove the X-drive cover.	
3. Remove all screws holding the base cover. 4. Lift and pull out the base cover.	 

6.2.4 Replacing Absolute Encoder

The three main motions, detector rotate, detector vertical and detector horizontal, each have an absolute encoder that can be replaced in the field. The process of replacing an absolute encoder is straightforward. However, when an absolute encoder has been replaced, the corresponding axis must be recalibrated. To calibrate an axis, follow the appropriate procedure provided in Chapter 4 *Calibration*.

6.2.5 Replacing Cables in Conduits

The cable conduits connecting the table base with the gantry electronics to the detector, gantry base, and Y pillar can be opened.

When a cable within a conduit must be replaced:

1. Disconnect both ends of the cable conduit.
2. Remove the outer conduit:

Open the sleeve and pull the inner conduit with the cables through.

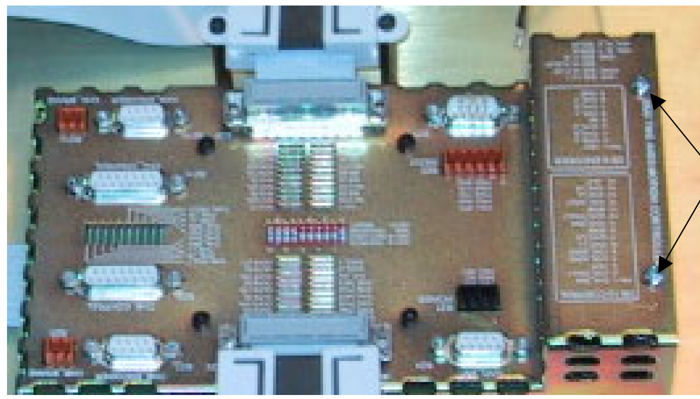
3. Remove the faulty cable from the inner conduit through the sleeve and insert the new cable in the same manner.
4. Put back the outer conduit and connect the combined conduit at both ends.

6.2.6 Replacing a Motion Controller

Procedure	***Details***

To replace a motion controller:

1. Unplug all cables to the motion controller
2. Unscrew the two Phillips screws as shown in the photo on the right.



Take the motion controller out of its chassis:

3. Carefully pull out the end where the Phillips screws came out by about 3 cm.
4. Slide the other end out of the chassis (two latches are holding this end down).

When a replacement motion controller is installed, its DIP switches must be set according to its allocation. See Table 6.1.

Switch #	***Master motion controller***	***Slave motion controller***
1	ON (Up)	OFF (Down)
2	ON (Up)	OFF (Down)
3	OFF (Down)	ON (Up)
4	ON (Up)	ON (Up)
5	ON (Up)	ON (Up)
6	OFF (Down)	OFF (Down)
7	OFF (Down)	OFF (Down)
8	OFF (Down)	OFF (Down)
9	OFF (Down)	OFF (Down)
10	OFF (Down)	OFF (Down)

Table 6.1 Motion controller DIP switch settings

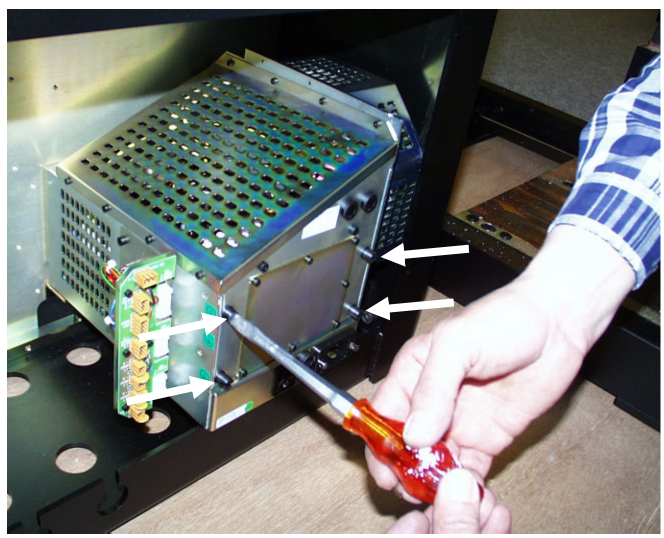
Procedure	***Details***

After replacing the motion controller, check whether it has the correct software:

5. Power up the CardioMD system and the

Procedure	*Details*
acquisition PC.	
6. Open the latest log file in the acquisition PC directory `C:\cardiocam\SystemLog`.	
7. Check that both motion controllers have the same software version.	
See Chapter 7 *Software Update Procedures*, the section *Checking Installed Software Versions*, for detailed instructions.	
8. If they do not, update motion controller software.	
See Chapter 7 *Software Update Procedures* for instructions.	

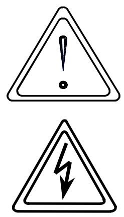
6.2.7 Replacing the Power Supply

Procedure	*Details*
To replace the AC mains power supply: 1. Unplug all cables to the power supply. 2. Unscrew the four bolts fixating the power supply to the mounting plate inside the table console. **Note**. The mounting plate works as heat sink for the power supply. The power supply must be firmly mounted on the plate when powered.	

6.3 Detector Repairs

6.3.1 General

To perform repairs inside a detector, it is most convenient to place the detector with the collimator surface horizontal facing the floor. Before turning the power off, place the detector in this position by means of the hand controller.



WARNING

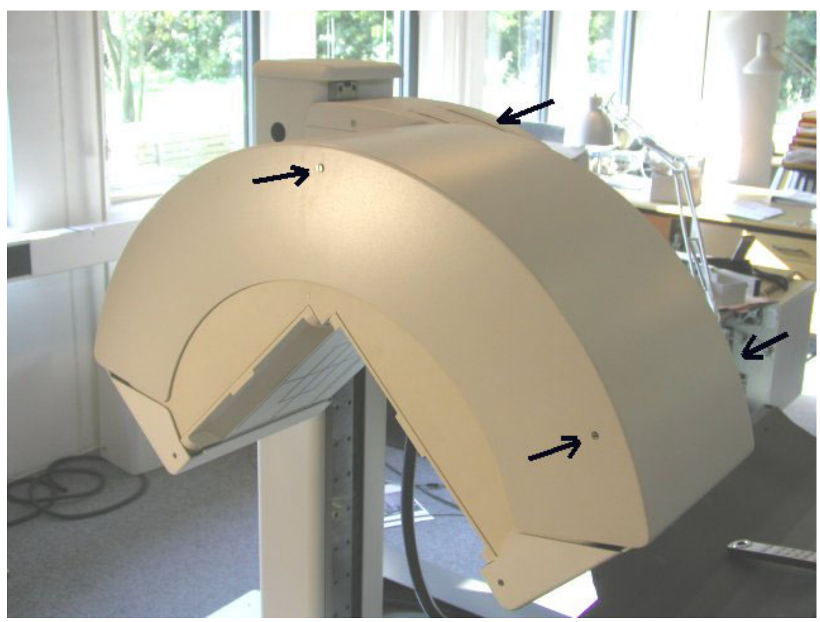
High voltage is present inside the detectors. Remove power to detectors before removing internal covers.

6.3.2 Tools

In addition to the tools listed for gantry repairs, a 5.5 mm and a 10 mm fork wrench are needed to disassembly the detectors.

Optical couplant grease is needed when a PMT is replaced.

6.3.3 Removing and Remounting the Detector Cover

Procedure	*Details*
1. Rotate the detector to – 45°. 2. Remove two slotted screws at the top and two M4 Allen screws at one end. **Note**. Lock washers are applied under the M4 Allen screws. 3. Hold the cover with a hand at each end and lift the cover up. Units are located directly under the detector top cover. 4. Remove the top cover and disconnect all cables from the unit to be removed.	

6.3.4 Replacing Detector Power Supply and EDC Board

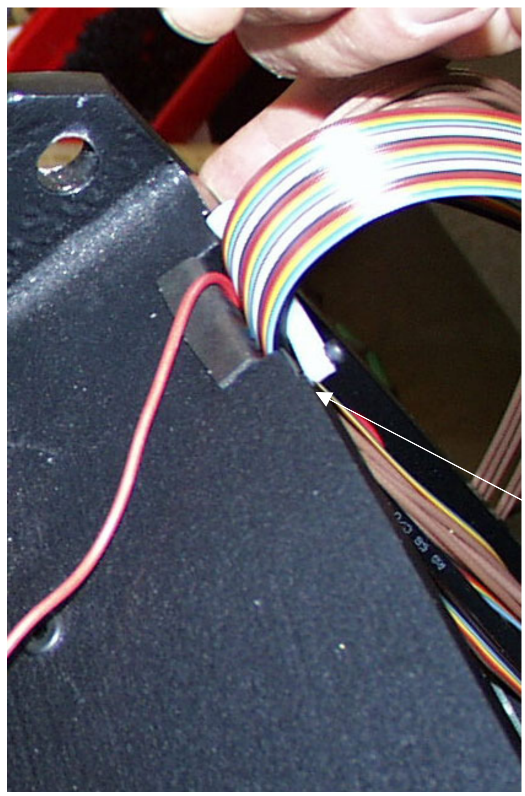
Procedure	*Details*
These units are located directly under the detector top cover.	
1. Remove the top cover and disconnect all cables from the unit to be removed.	
To remove the EDC module:	
2. Unscrew the 4 screws attaching the EDC module to its support plate.	
3. Set the detector selector switch to position DET1 or DET2, depending on the detector at which the module is mounted.	
After mounting the new EDC module, check whether it has the correct software:	
4. Power up the CardioMD system and the acquisition PC.	
5. Open the latest log file in the acquisition PC directory `C:\cardiocam\SystemLog`.	
6. Check that both EDC modules have the same software version.	
See Chapter 7 *Software Update Procedures*, the section *Checking Installed Software Versions*, for detailed instructions.	
7. If they do not, update EDC software.	
See Chapter 7 *Software Update Procedures* for instructions.	

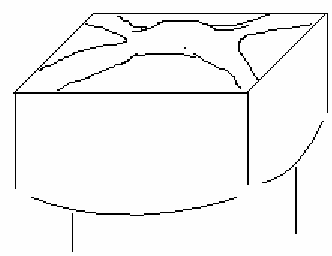
6.3.5 Replacing PMT's

WARNING

Changing PMT's should only be carried out using safety glasses and rubber gloves.

Note. New PMT's supplied as spare parts look different from PMT's installed in older CardioMD systems. The changes in appearance of PMT's are due solely to requirements in production and have no effect on the functioning of PMT's. Old PMT's can be replaced with new ones without problems. See also Chapter 9 *Spare Parts* for details.

Procedure	***Details***
1. Disassemble the detector as far as described above. 2. Remove all six PMT strips and the power strip. 3. Disconnect all cables and remove the cable bracket.	
4. Unscrew the 8 M6 screws to remove the strip mounting plate. 5. Remove the rubber light seal tube along the edges. **Note**. When reassembling, take care that the tube is being firmly pressed between the PMT support plate and the strip mounting plate. The tube light seals the detector. 6. Remove the four screws along the short edges of the PMT support plate, and lift the support plate out.	

Procedure	*Details*
7. Remove the rubber seal from the faulty PMT.	
8. Grasp the glass neck of the faulty PMT and pull carefully away from the crystal, turning the PMT slightly back and forth.	
A slight tilt force at the same time is helpful. After a while the PMT will come loose.	
9. Lift the PMT out.	
10. Use a plastic spatula, for example a plastic ruler, to wipe the old coupling compound away from the crystal surface.	
11. Check that the face plate of the replacement PMT is clean. Press approx. 1 cm (3/16") strip of optical couplant onto the center of the PMT face plate. Be careful that no air bubbles are trapped in the couplant.	
12. Use the plastic spatula (ruler) to smear out part of the blob towards each of the corners of the PMT face plate. Ensure that the layer is still thickest around the center.	
13. Rotate the PMT to position the connector consistently with the other PMT's. Align the PMT and press down to seat the PMT on the face of the crystal. Apply pressure to such an extent that excess couplant appears around all four edges.	
14. Remount the rubber seal.	
15. Remount the detector by reversing the procedure described above.	
16. Before remounting the lead covers, power up the system and run a few iterations of PMT update calibration. See the CardioMD Operator's Manual Chapter 5 *Maintenance* for instructions.	
17. Assess the images to see if the new PMT matches the rest of the PMT's.	
If the new PMT shows a pronounced pattern,	

Procedure	***Details***
the LED aperture should be changed. **Note**. To change the LED aperture, turn the slot on the back of the PMT. The slot can be accessed with a screwdriver through a hole in the PMT strip board. 18. Remount the rest of the detector and run a complete PMT update calibration. 19. Run a QC check to determine if further calibrations are required. See the CardioMD Operator's Manual Chapter 5 *Maintenance* for instructions.	

6.3.6 Replacing the Crystal

Procedure	***Details***
1. Disassemble the detector and remove all 24 PMT's. Follow instructions provided in the previous sections.	
2. Unscrew the mu-metal support plates mounted on the two short edges of the detector. 3. Lift out the mu-metal support plates. 4. Disconnect the internal HV cable from the mu-metal assembly.	
5. Loosen the two set screws in the support brackets in each side. To remove the brackets: 6. Unscrew the 3 screws going through the detector casting from the outside and the 3 screws going through the detector casting from the power supply compartment. 7. Disconnect the internal HV cable from the crystal and lift up the crystal. 8. Remove the gasket – or remainders of the gasket – from the crystal seating inside detector casting.	

Procedure	*Details*
9. Make sure that the new crystal has a gasket placed on its seat.	
10. Put down the new crystal and connect the HV cable. 11. Place a GeoCal calibration mask in the collimator's place. 12. Position the crystal so that the holes in the GeoCal mask line up exactly with the corresponding marks on the front of the crystal. **Note**. The print on the crystal cover may not be entirely centered. If this is the case, position the crystal so that the marks on the crystal front are off-centered equally with the holes in the GeoCal Mask.	
13. Mount the two crystal support brackets, making sure that no cables get pinched under the brackets. Tighten the set screws in the brackets.	
14. Put down the mu-metal assembly and center it relative to the crystal.	
15. Assemble the detector, reversing the procedure described above.	

6.3.7 Replacing the Collimator ID Cable

Procedure	*Details*
The collimator ID cable connects the detector contact board that engages the collimator to the EDC module. To change this cable the detector must be disassembled to the same level as for changing PMT's.	

1. Follow the procedure to this stage as described in section 0 on page 6-7.
2. Remove the collimator support cover by unscrewing the 4 cover screws in the plate next to the collimator.
3. Disconnect the cable from the detector contact board and from the EDC module.
4. The cable's exit hole in the detector casting is sealed with black RTV. Use a knife to remove the old seal and replace the cable.
5. Connect the cable to the detector contact board and seal the exit hole once again with black RTV.
6. Route the cable to the EDC module and re-assemble the detector.

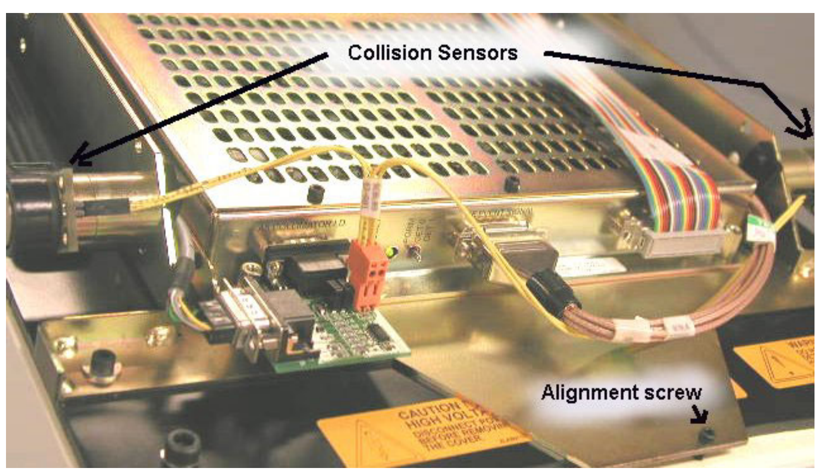
6.3.8 Aligning Collision Sensors on the Detector Cover

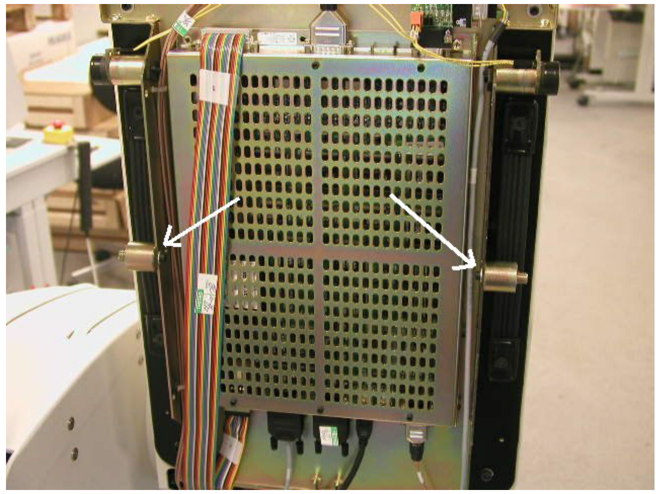
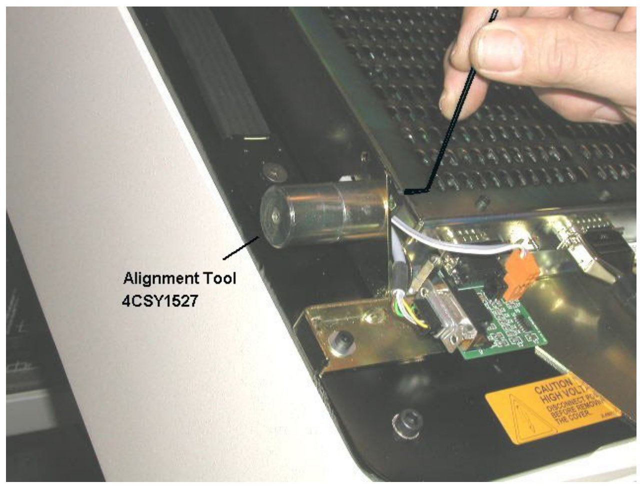
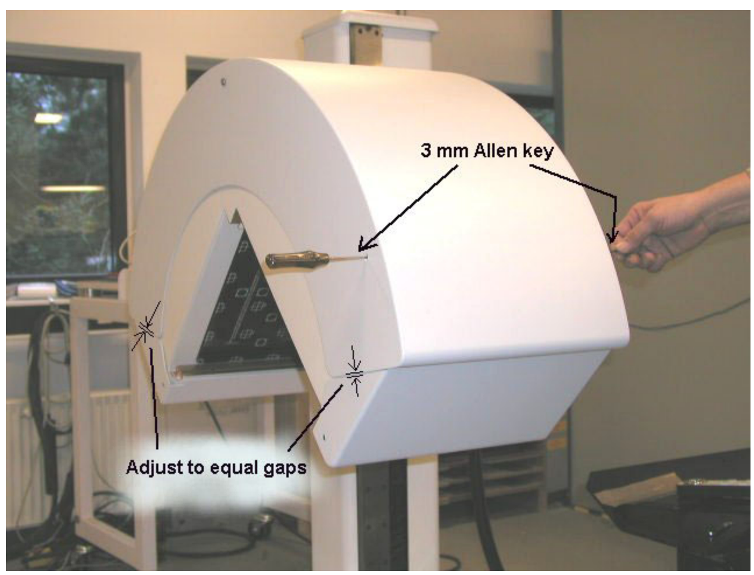
Procedure	*Details*

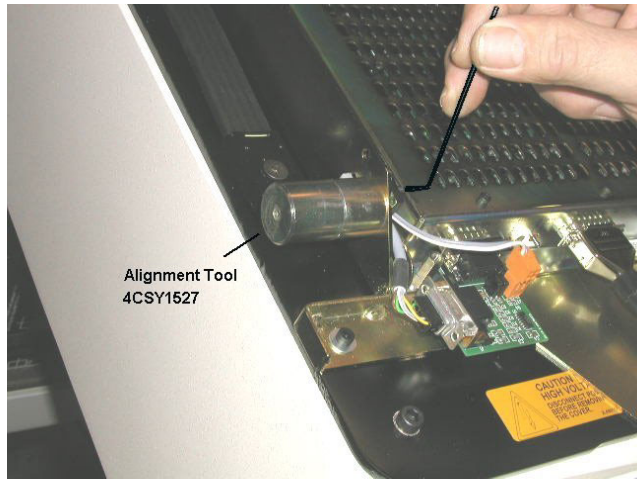
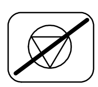
1. Remove the detector cover as described in section 6.3.3 on page 6-6.

The collision sensors for the detector cover are located where the two M4 Allen screws were removed.

2. Unplug the cables from the collision sensors and turn the sensors counterclockwise to loosen them. Remove the sensors.
3. Make sure that the M3 bracket alignment screw is in place.



Procedure	*Details*
4. Unscrew the two alignment tools located on the EDC bracket. If it turns out that these tools are not located as shown and have to be retrieved from elsewhere, make sure they are put back as shown in the photo on the right.	
5. In both sides of the detector, screw the alignment tools into the locations where the sensors were removed. 6. Using a 2 mm Allen key, loosen the upper set screw on the back of each sensor support. See the photo on the right.	
7. Remount the detector cover, this time with only the two slotted pivot screws at top. 8. Slide a 3 mm Allen key into each of the 4 mm screw holes, all the way through the aligment tools and loosen the screw in the bottom of each sensor support. 9. With the Allen key staying in the hole (preferably a key in the hole on both sides), rock the cover around its pivot points to a position where it has equal clearance to the two end covers. In this way, the sensor supports get aligned with the corresponding holes in the detector cover. 10. Tighten the screws at the bottom of the holes securely.	

Procedure	Details
11. Remove the detector cover again. 12. Using a 2 mm Allen key, tighten the upper set screw on the back of each sensor support.	
13. Remove the alignment tools and place them in their original stand-by locations. 14. Screw the collision sensors back into their original locations and connect the cables. 15. Remount the detector cover using all its screws. Make sure that the M4 Allen screws have their lock washers applied. 16. Check the cover collision by rocking the cover in both directions around its pivot point. A collision should be detected in both directions.	
17. Rotate the detector to 45° and check that collisions in both directions can be cleared when using the hand controller Collision Override button. 18. Rotate the detector to – 45° and check that collisions in both directions can be cleared when using the Collision Override button.	

7 SOFTWARE UPDATE PROCEDURES

Contents

7.1 Introduction

This section comprises a set of procedures to be followed when updating or reinstalling software in the CardioMD system.

Procedures for programming collimator and detector ID's are also provided.

7.2 Gantry Software Updates

7.2.1 Closing Down Acquisition Software

Before attempting to update gantry software, make sure to close down the CardioMD acquisition software:

Procedure	***Details***
1. If the CardioMD acquisition PC is not displaying the Persistence page, click the Exit button to return to the Persistence page.	
2. On the Persistence page, click the Close button in the upper right corner of the CardioMD application window.	

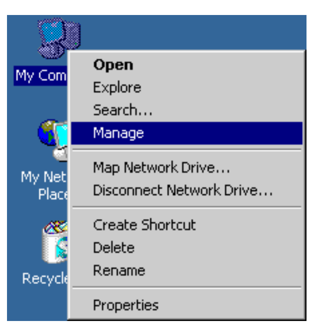
7.2.2 Determining which COM Port to Use

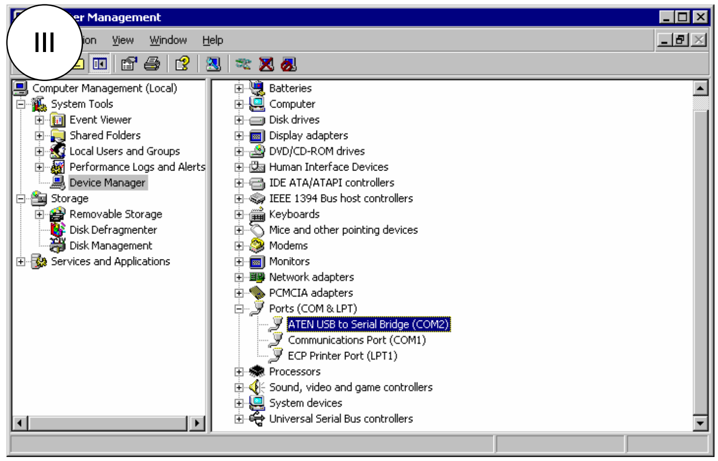
III

When using a laptop acquisition PC with the CardioMD system (Series III systems), you use the PC's USB interface to communicate with the CardioMD system via RS 232. This is accomplished by using a USB to RS 232 adapter to connect the RS 232 cable to one of the PC's USB ports. This section explains how to determine which COM port you are using for the communication.

I, II

Note. When using a tower acquisition PC with the CardioMD system, you should always connect the RS 232 cable to the COM1 serial port.

Procedure	***Details***
When using a laptop acquisition PC, you may need to check which COM port the USB to RS 232 adapter uses:	III
1. Connect the USB to RS 232 adapter to the USB port that you will be using.	
2. On the acquisition PC's desktop, right-click the My Computer icon and select Manage from the pop-up menu.	III 

Procedure	***Details***
The Computer Management window appears. 3. In the left-hand pane, select Device Manager. 4. In the right-hand pane, click the + next to the entry Ports (Com & LPT). 5. Check the COM port number stated next to the item ATEN to USB Serial Bridge. This is the COM port you are using.	

7.2.3 Upgrading EDC Firmware

The EDC modules contain two software packages: One for the on-board micro controller and one package for the programmable logic devices on the board.

The EDC Module is available in several hardware versions requiring different procedures for loading software. Check the version of the EDC modules on your detector to determine the revision. According to the revision (9CSY0900-A01 or 9CSY0900-B02 or higher), follow the appropriate procedure below. All versions of the EDC board can be updated using the current version of the EDC software.

CAUTION

Caution. Both EDC modules must *always* have the same software version installed.

7.2.3.1 Tools Required

- NULL modem serial interface cable (DB9-female to DB9-female)
- CardioMD software installation CD, part number 9CSY0906

III

- When using a laptop acquisition PC (CardioMD Series III): An USB to RS 232 adapter, part no. 3ACQ1669.

7.2.3.2 Upgrading EDC Modules 9CSY0900-A01

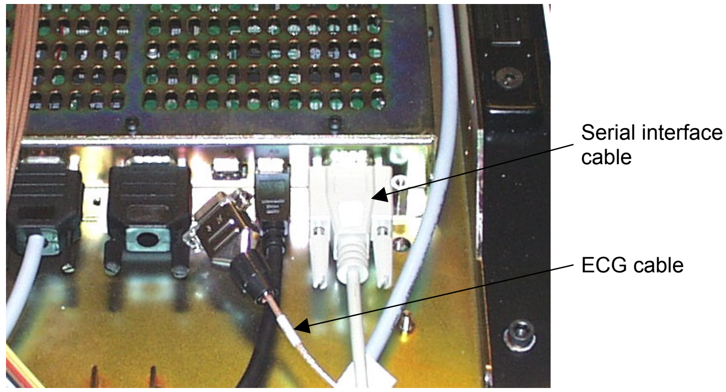
Preparing for Firmware Upgrade

Before starting the installation, check the release note on the CD-ROM. You find the release note in the directory `Release notes`. The release note may provide information that is more recent than this manual.

Note. In this section, it is assumed that you are using a tower acquisition PC to perform the EDC module upgrade and that you are using the COM1 serial port.

Procedure	***Details***

1. Remove the detector top cover to access the EDC modules. See instructions in Chapter 6 *Repair Procedures*.
2. Remove the ECG cable from the ECG port labeled A1 RS232.
3. Connect one end of the serial interface cable to this port.
4. Connect the opposite end of the cable to the acquisition PC's COM1 serial port.



5. Insert the software installation CD-ROM in the acquisition PC's CD-ROM drive.

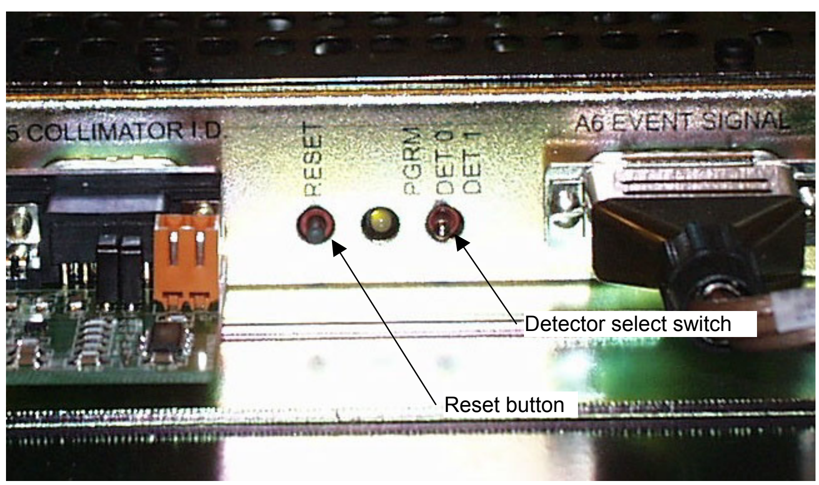
Upgrading Micro Controller Firmware

Procedure	***Details***

To load micro controller firmware to the EDC Board, you must start the Flash program. Proceed as follows:

1. In the Windows Explorer, select the folder `EDC CardioMD programming for Module rev. 9CSY0900-A01` on the CD-ROM.
2. In this folder, double-click the icon `flash.exe` to start the Flash program.
3. Locate the Reset button and Detector select switch on the EDC board.
4. While holding the Detector select switch towards the Reset button (momentary switch function), press the Reset button.

Note. Ensure that the Detector Select switch is returned to the correct position: DET 0 for detector 1 and DET 1 for detector 2.



5. At the `FLASH_COMMAND>` prompt, enter the command `Connect` and press [Enter].

If the command aborts with a timeout, check the cable and the COM port. Alternatively, try

Procedure	***Details***

resetting the EDC board again as explained in step 4.

6. When the command completes successfully, enter the command `ERASEALL` and press [Enter].
7. Wait until all four memory banks have been erased.
8. Enter the command `PROGRAM`, followed by the name of the data file to be downloaded.

The name of the data file is of the form `70095Xnn.hex` where `Xnn` is the revision of the firmware. The data file is located in the same CD-ROM directory as the `flash.exe` program (`EDC CardioMD programming for Module rev. 9CSY0900-A01`).

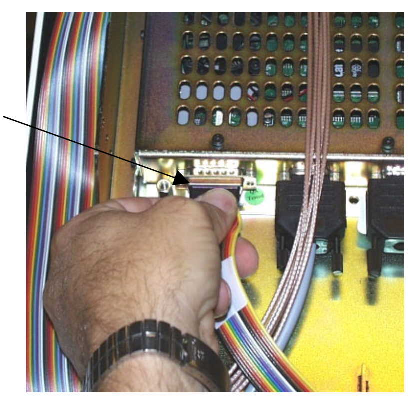
The programming will take a few minutes.

9. When the programming has completed without reporting errors, enter the command `QUIT` to exit the Flash program.
10. Reset the EDC board. This time, only press the EDC board's Reset button.

If you also need to upgrade the logic firmware of the EDC board, proceed to the section *Upgrading Logic Firmware* on page 7-6. If not, continue with the instructions below.

After the micro controller software has been upgraded, the ECG connection must be restored and the EDC module must be power cycled:

Connector A4 POWER on the EDC board



11. Remove the serial interface cable from the connector A1 RS232 and reconnect the ECG cable (see step 2 in the section *Preparing for Firmware Upgrade* on page 7-4).
12. Remove the EDC power cable connected to connector A4 POWER. Reconnect the power cable cable.

Now proceed to upgrade the micro controller firmware of the other EDC board:

13. Connect the serial interface cable to the other EDC board as described on page 7-4.

Procedure	***Details***
14. Repeat steps 1 (page 7-4) to 12 (page 7-5) of this procedure to update the micro controller firmware of the EDC module on the other detector.	
15. When both EDC modules have been updated, remount the detector top cover following instructions provided in Chapter 6. *Repair Procedures*.	

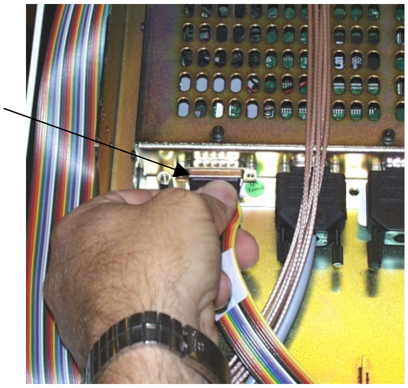
Upgrading Logic Firmware

Procedure ***Details***

To download logic firmware to the EDC board, you use the terminal emulator program ttermpro. Proceed as follows:

1. In the Windows Explorer, select the folder `EDC CardioMD programming for Module rev. 9CSY0900-A01\TTERMPRO` on the CD-ROM.
2. In this folder, double-click the icon `ttermpro.exe` to start the ttermpro program.
3. Press [Enter] to check if the terminal prompt -> is present. If the prompt does not appear, check the serial port setup:
   Baudrate: 57600
   Data: 8
   Parity: none
   Stop: 1
   Flow control: hardware (or none)
   Transmit delay: 0 and 1 communication.
4. At the terminal prompt, type the following commands:
   ```
   -> dspreset
   -> ispsvf
   ```
5. In the File menu, select **Send File**.
6. Select the file `LSI.svf` in the folder `EDC CardioMD programming for Module rev. 9CSY0900-A01` on the CD-ROM, and click Open.

A pop-up appears counting the number of bytes transferred. When the firmware is successfully loaded, the pop-up closes automatically. At this point, the EDC module no longer

Procedure	***Details***
responds to commands in the ttermpro emulator. This is normal. Now the ECG connection must be restored and the EDC module must be power cycled: 7. Remove the serial interface cable from the connector A1 RS232 and reconnect the ECG cable (see step 2 in the section *Preparing for Firmware Upgrade* on page 7-4). 8. Remove the EDC power cable connected to connector A4 POWER. Reconnect the power cable. Now proceed to upgrade the logic firmware of the other EDC board: 9. Connect the serial interface cable to the other EDC board as described on page 7-4. 10. Repeat steps 1 to 8 of this procedure to upgrade the logic firmware of the EDC module on the other detector. 11. When both EDC modules have been updated, remount the detector top cover following instructions provided in Chapter 6. *Repair Procedures*.	Connector A4 POWER on the EDC board 

7.2.3.3 Upgrading EDC Modules 9CSY0900-B02 or higher

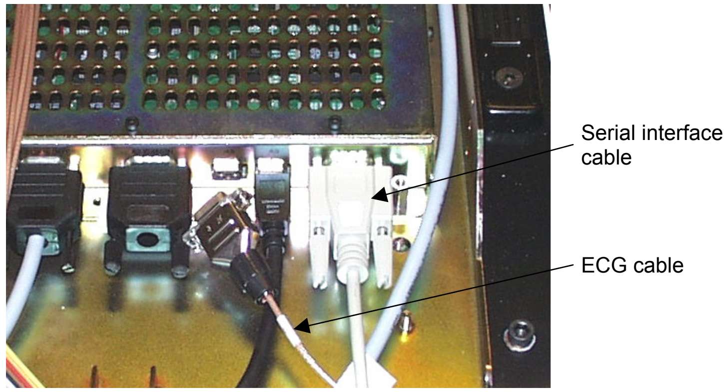
Before starting the installation, check the release note on the CD-ROM. You find the release note in the directory `Release notes`. The release note may provide information that is more recent than this manual.

Note. If you are using a laptop acquisition PC, make sure that you will be using either COM1 or COM2 to communicate, since the software used for downloading only supports these ports. See section 7.2.2 on page 7-2 for instructions on determining the COM port number.

Preparing for Firmware Upgrade

Procedure	***Details***

1. Remove the detector top cover to access the EDC modules. See instructions in Chapter 6 *Repair Procedures*.
2. Remove the ECG cable from the ECG port labeled A1 RS232.
3. Connect one end of the serial interface cable to this port.



If you are using a laptop acquisition PC:

III

4. Use the USB to RS 232 adapter to connect the opposite end of the serial interface cable to one of the acquisition PC's USB ports.

See section 7.2.2, page 7-2 for instructions on determining which COM port you are using.

If you are using a tower acquisition PC:

I, II

5. Connect the opposite end of the cable to the acquisition PC's COM1 serial port.
6. Insert the software installation CD-ROM in the acquisition PC's CD-ROM drive.

I, II III

Upgrading Micro Controller Firmware

Procedure	***Details***

To load micro controller firmware to the EDC Board, you must start the Flash program. Proceed as follows:

1. In the Windows Explorer, select the folder `EDC CardioMD programming for Module rev. 9CSY0900-B02 or later` on the CD-ROM.
2. In this folder, double-click the icon `flash.exe` to start the Flash program.

Procedure | ***Details***

3. Click Select Hex file and browse to find the file to download.
4. Select the file with a name similar to `70095Xnn.hex` located in the CD-ROM folder `EDC CardioMD programming for Module rev. 9CSY0900-B02 or later` and click Open.

`Xnn` is the revision number of the micro controller firmware.

5. Select the COM port used.
6. Click Program Target Device.

The program issues the message:
`Please ensure that the Target Board is in Bootstrap Loader Mode.`

When you see this message:

7. Locate the Reset button and Detector select switch on the EDC board.
8. Hold the Detector Select switch in position PGRM (toward the Reset button).
9. While holding the Detector Select switch toward the Reset button (momentary switch function), press the Reset button.

Note. Ensure that the Detector Select switch is returned to the correct position: DET 0 for detector 1 and DET 1 for detector 2.

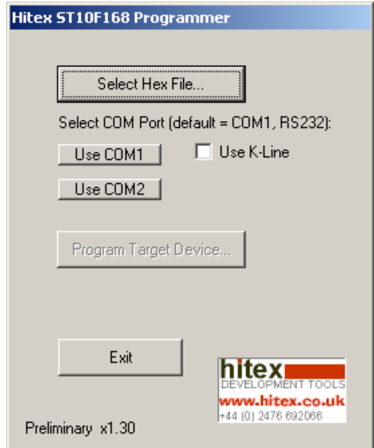
10. Click OK to download the software to the EDC Module.

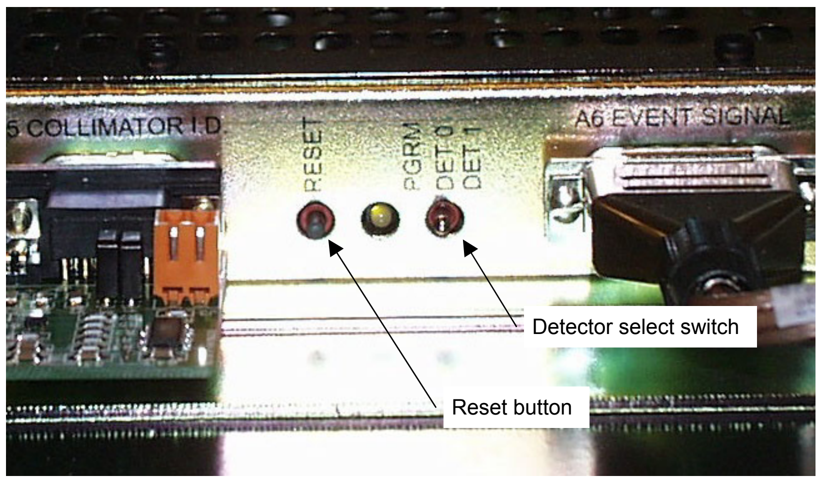
A progress bar should now appear.

Note. If an error message appears instead of the progress bar, click OK and repeat from step 6 to try again.

11. Wait until the progress bar disappears and a completion message appears. Click OK.
12. Click Exit to close the Flash program.
13. Reset the EDC board. This time, only press the EDC board's Reset button.

If you also need to upgrade the logic firmware of the EDC board, proceed to the section *Upgrading Logic Firmware* on page 7-10. If

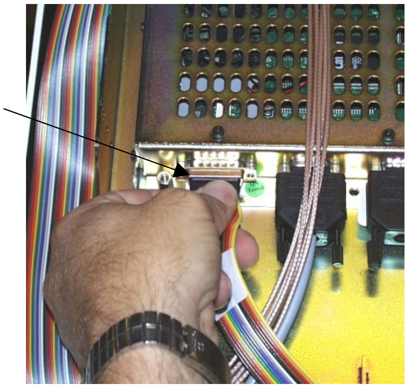




Procedure	***Details***
not, continue with the instructions below.	

After upgrading the EDC board's micro controller firmware, the ECG connection must be restored and the EDC module must be power cycled:

14. Remove the serial interface cable from the connector A1 RS232 and reconnect the ECG cable (see step 2 in the section *Preparing for Firmware Upgrade* on page 7-8).
15. Remove the EDC power cable connected to connector A4 POWER. Reconnect the power cable.



Proceed to upgrade the micro controller firmware of the other EDC board:

16. Connect the serial interface cable to the other EDC board as described on page 7-8.
17. Repeat steps 1 (page 7-8) to 15 (page 7-10) of this procedure to update the micro controller firmware of the EDC module on the other detector.
18. When both EDC modules have been updated, remount the detector top cover following instructions provided in Chapter 6. *Repair Procedures*.

Upgrading Logic Firmware

Procedure	***Details***

To download logic firmware to the EDC board, you use the terminal emulator program ttermpro. Proceed as follows:

1. In the Windows Explorer, select the folder `EDC CardioMD programming for Module rev. 9CSY0900-B02 or later\TTERMPRO` on the CD-ROM.
2. In this folder, double-click the icon `ttermpro.exe` to start the ttermpro program.

Procedure	***Details***

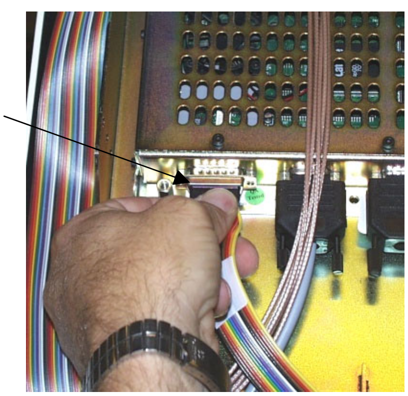
3. Press [Enter] to check if the terminal prompt -> appears. If the prompt does not appear, check the serial port setup (select Serial port from the Setup menu):
   Correct COM port selected
   Baudrate: 57600
   Data: 8
   Parity: none
   Stop: 1
   Flow control: hardware (or none)
   Transmit delay: 0 and 1 communication.
4. At the terminal prompt, type the following commands:
   `-> dspreset`
   `-> ispsvf`
5. In the File menu, select **Send File**.
6. Select the file `LSI.svf` in the folder `EDC CardioMD programming for Module rev. 9CSY0900-B02 or later` on the CD-ROM, and click Open.

A pop-up appears counting the number of bytes transferred. When the software is successfully loaded, the pop-up closes automatically. At this point, the EDC module no longer responds to commands in the ttermpro emulator. This is normal.

Now the ECG connection must be restored and the EDC module must be power cycled:

7. Remove the serial interface cable from the connector A1 RS232 and reconnect the ECG cable (see step 2 in the section *Preparing for Firmware Upgrade* on page 7-8).
8. Remove the EDC power cable connected to connector A4 POWER. Reconnect the power cable.

Connector A4 POWER
on the EDC board



Now proceed to upgrade the logic firmware of the other EDC board:

9. Connect the serial interface cable to the other EDC board as described on page 7-8.
10. Repeat steps 1 (page 7-10) to 8 (page 7-11) of this procedure to upgrade the logic firmware

Procedure	***Details***
11. When both EDC modules have been updated, remount the detector top cover following instructions provided in Chapter 6. *Repair Procedures*.	

7.2.4 Collimator ID Programming

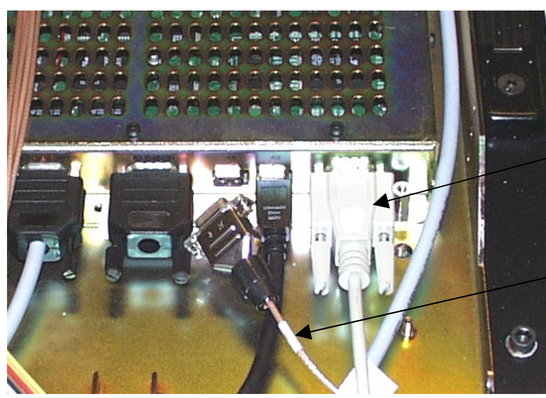
The collimator type ID is programmed into an EEPROM located on the collimator contact board.

7.2.4.1 Tools Required

- CardioMD software installation CD, part number 9CSY0906
- NULL modem serial interface cable (DB9-female to DB9-female).
- III When using a laptop acquisition PC (CardioMD Series III): An USB to RS 232 adapter, part no. 3ACQ1669.

7.2.4.2 Procedure

Before starting the collimator ID programming, check the release note on the CD-ROM. You find the release note in the directory `Release notes`. The release note may provide information that is more recent than this manual.

Procedure	***Details***
1. Remove the detector top cover to access the EDC modules. See instructions in Chapter 6 *Repair Procedures*. 2. Remove the ECG cable from the ECG port labeled A1 RS232. 3. Connect one end of the serial interface cable to this port.	
If you are using a laptop acquisition PC: 4. Use the USB to RS 232 adapter to connect the opposite end of the serial interface cable to one of the acquisition PC's USB ports.	III
See section 7.2.2, page 7-2 for instructions on determining which COM port you are using.	
If you are using a tower acquisition PC: 5. Connect the opposite end of the cable to the acquisition PC's COM1 serial port.	I, II

Procedure	***Details***
6. Insert the software installation CD-ROM in the acquisition PC's CD-ROM drive.	I, II III
To program the collimator ID, you use the terminal emulator program ttermpro. Proceed as follows:	
7. In the Windows Explorer, select the folder `EDC CardioMD programming for Module rev. 9CSY0900-B02 or later\TTERMPRO` on the CD-ROM.	
8. In this folder, double-click the icon `ttermpro.exe` to start the ttermpro program.	
9. Press [Enter] to check if the terminal prompt -> is present. If the prompt does not appear, check the serial port setup (select Serial port from the Setup menu): Correct COM port selected Baudrate: 57600 Data: 8 Parity: none Stop: 1 Flow control: hardware (or none) Transmit delay: 0 and 1 communication.	
10. In the File menu, select **Send File**.	
11. In the folder `ID programming` on the CD-ROM, select one of the files `7PRG0260 (LEGP).txt` and `7PRG0261 (LEHR).txt`.	
Select the file corresponding to the type of collimator currently mounted on the detector.	
12. Click Open.	
A pop-up appears counting the number of bytes transferred. When the ID programming is completed successfully, the pop-up closes automatically.	
13. Close the ttermpro program.	
The ECG connection must be restored:	
14. Remove the serial interface cable from the connector A1 RS232 and reconnect the ECG cable (see step 2 on page 7-12).	
15. Remount the detector top cover. See instructions in Chapter 6. *Repair Procedures*.	

7.2.5 Upgrading Motion Controller Firmware

Note. The two motion controllers must always have the same software version installed.

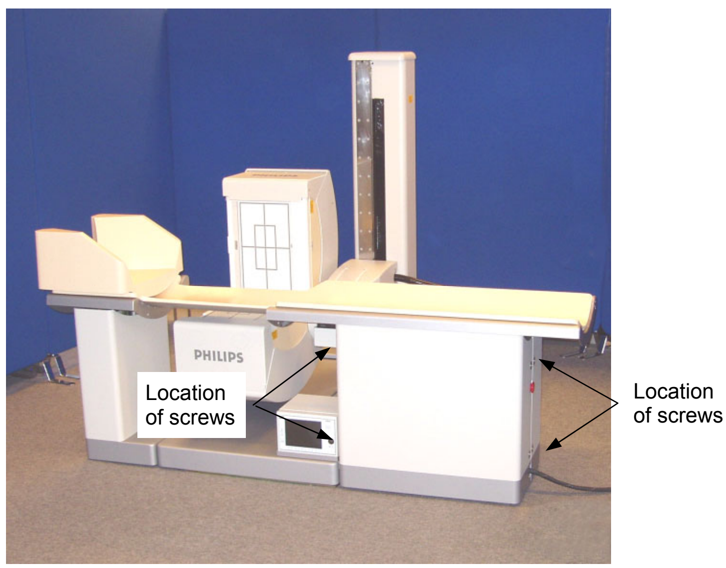
7.2.5.1 Tools Required

- CardioMD software installation CD, part number 9CSY0906
- SW load cable (RS 232 cable) for motion controller, part number 9CBL0818
- III When using a laptop acquisition PC (CardioMD Series III): An USB to RS 232 adapter, part no. 3ACQ1669.

7.2.5.2 Procedure

Before starting the motion controller firmware update, check the release note on the CD-ROM. You find the release note in the directory `Release notes`. The release note may provide information that is more recent than this manual.

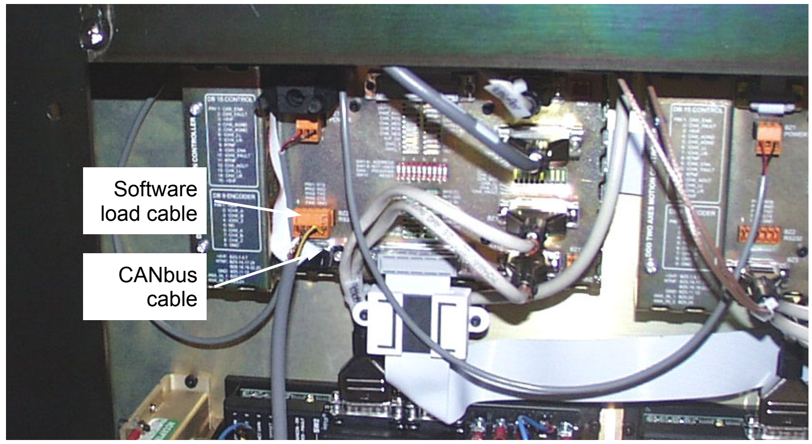
Note. If you are using a laptop acquisition PC, make sure that you will be using either COM1 or COM2 to download firmware to the motion controller, since the software used for downloading only supports these ports. See section 7.2.2 on page 7-2 for instructions on determining the COM port number.

Procedure	***Details***
To access the motion controller modules, you must remove the front cover from the table console: 1. Unscrew the 2 Allen screws in each side. 2. For safety reasons, cut power to the motors by pressing one of the Emergency Stop buttons.	 **Note.** The appearance of your system may be slightly different from the system shown in the photograph above. However, there is no difference in the location of the screws

Procedure	*Details*

3. Connect the SW load cable to the motion controller serial port labeled BZ2 RS232.

This does not require that any existing cables be removed.



If you are using a laptop acquisition PC:

III

4. Use the USB to RS 232 adapter to connect the opposite end of the SW load cable to one of the acquisition PC’s USB ports.

See section 7.2.2, page 7-2 for instructions on determining which COM port you are using.

If you are using a tower acquisition PC:

I, II

5. Connect the opposite end of the cable to the acquisition PC’s COM1 serial port.

Note. Downloading software to the motion controller does not require the use of a NULL modem cable.

6. Disconnect the CANbus cable between the two motion controllers by unplugging the cable connected to CAN_IN on the slave motion controller (controller to the left).
7. Insert the software installation CD in the CD-ROM drive.

To download software to the motion controller, you must start the Flash program. Proceed as follows:

8. In the Windows Explorer, select the folder `MC` on the CD-ROM.
9. In this folder, double-click the icon `flash.exe` to start the Flash program.

Procedure	*Details*

10. Click Select Hex File and browse the `MC` folder on the CD-ROM to find the file to download.

The file name is of the form `7MOT0096Xnn.h86`, where `Xnn` is the version of the software.

11. Click Open.
12. Select the COM port used.
13. Click Program Target Device

The program issues the message: `Please ensure that the Target Board is in Bootstrap Loader Mode.`

When you see this message:

14. Set SW10 on the motion controller in position UP to reset the motion controller.
15. Set SW9 in position UP to set the motion controller in program mode.
16. Set SW10 back to DOWN position to remove the reset.
17. Click OK to download the software to the motion controller.

A progress bar should now appear.

Note. If an error message appears instead of the progress bar, press OK and repeat from step 13 to try again. Refer to the `Readme.txt` file in the `MC` folder on the CD-ROM for further details.

18. Wait until the progress bar disappears and a completion message appears. Click OK.
19. Set SW9 on the motion controller back in the DOWN position.
20. Set SW10 UP and then DOWN to reset the motion controller.

To update other motion controller:

21. Connect the SW load cable to the other motion controller.
22. Repeat step 13 to 20 to download software to the other controller.
23. Click Exit to close the Flash program.

Procedure	*Details*
24. Remove the SW load cable and reconnect the CANbus cable to the CAN_IN connector of the slave motion controller.	
Note. After the programming, it is important that the motion controllers start up in the right sequence as the motion controllers must synchronize to each other via a bi-directional communication link. For safety reasons, the two motion controllers supervise each other and disable all motions in case of faults.	
Proceed as follows:	
25. Reset both motion controllers (SW10 in position up).	
26. Then remove the reset on the master motion controller (motion controller to the right – SW10 in position down).	
27. Finally, remove the reset on the slave motion controller (motion controller to the left – SW10 in position down).	
As an alternative to resetting both motion controllers, you can power cycle the gantry. This ensures that the motion controllers start up correctly:	
28. Shut down the Acquisition PC.	
29. Switch gantry power off and then back on.	
30. Remount the front cover on the table cabinet.	
31. Remove the E-Stop and press the hand controller Collision Override button to enable power to the motors.	

7.3 Acquisition PC Software Updates

The CardioMD software CD-ROM includes two batch files that are used to update or completely install the acquisition software.

7.3.1 Upgrading CardioMD Acquisition Software

7.3.1.1 Tools Required

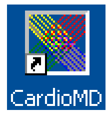
- CardioMD software installation CD, part number 9CSY0906.

Note. As a precaution, in case anything should go wrong, ensure that the previous version of the software CD-ROM is available in order to be able to restore the original acquisition software version.

7.3.1.2 Procedure

Before starting the acquisition PC software update, check the release note on the CD-ROM. You find the release note in the directory `Release notes`. The release note may provide information that is more recent than this manual.

Procedure	*Details*
Before starting the acquisition software upgrade, close down the CardioMD application:	
1. If the CardioMD application is not displaying the Persistence page, click the Exit button to return to the Persistence page.	
2. On the Persistence page, click the Close button in the upper right corner of the CardioMD application window.	
3. Close all other programs running on the acquisition PC.	
4. Insert the CardioMD software CD in the acquisition PC's CD-ROM drive.	
5. Start the Windows Explorer and select the CD-ROM drive.	
6. Run the file `InstallCardioMDupdate.bat` by double-clicking on the name of the file.	
The file is located in the root directory of the CD-ROM.	
7. Follow the instructions given.	
During the execution of the `.bat` file, you may several times see a message asking you whether existing files should be overwritten:	
8. Enter `A` to indicate that all files should be	

Procedure	*Details*
overwritten.	
9. When the software installation is completed, remove the software CD-ROM and store it in a safe place along with the backup disks.	
10. Start the CardioMD acquisition software by double-clicking the CardioMD icon on the acquisition PC's desktop.	

7.3.2 Performing a Complete Installation of the CardioMD Acquisition Software

7.3.2.1 Tools Required

- CardioMD software installation CD, part number 9CSY0906.

Note. A complete installation will overwrite all existing CardioMD acquisition software, detector calibrations, non-default protocols etc. Make sure that up-to-date backup disks are available before performing a complete software installation. Instructions for performing backup and restore of user data are provided in the Appendix of the CardioMD User's Manual.

Note. As a precaution, in case anything should go wrong, ensure that the previous version of the software CD-ROM is available in order to be able to restore the original acquisition software version.

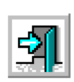
7.3.2.2 Procedure

Before starting the acquisition PC software installation, check the release note on the CD-ROM. You find the release note in the directory `Release notes`. The release note may provide information that is more recent than this manual.

Logging On as Administrator

I, II

To perform a complete software installation, you need administrator privileges on the acquisition PC. If your acquisition PC is running Windows XP, you already have administrator privileges. For Windows 2000, proceed as follows:

Procedure	*Details*
Close down the CardioMD application:	
1. If the CardioMD application is not displaying the Persistence page, click the Exit button to return to the Persistence page.	
2. On the Persistence page, click the Close button in the upper right corner of the CardioMD application window.	
3. Click the Windows Start button.	
4. Select **Shut Down**.	
5. In the drop-down list, select **Log off Car-**	

Procedure	***Details***
dioMD.	
If the menu item says **Log off Administrator**:	
6. Click Cancel and proceed to the next section.	
Otherwise:	
7. Click OK.	
The Log on to Windows dialog appears.	
8. In the User name field, enter `Administrator`. Ensure that the Password field is left blank.	
9. Click OK.	

Backing Up the Existing Software Version

I, II III

Note. As an extra precaution, if the CardioMD software is already installed on the acquisition PC, the existing version can be saved by copying it to a backup directory. This ensures that customized protocols, etc. are saved.

To back up the existing version of the CardioMD application software, copy the `C:\Cardiocam` directory to a working directory on the C: drive. Proceed as follows:

Procedure	***Details***
1. In the Windows Explorer's folder list, locate the `Cardiocam` directory.	
2. Right-click on the directory name and select Copy from the pop-up menu.	
3. In the folder list, select the root directory, C:\.	
4. Right-click in the file list, and select Paste from the pop-up menu.	
The system will create a new directory named `Copy of Cardiocam`.	

Installing the FireWire driver on Windows 2000

I, II

Note. This section applies to acquisition PC's running Windows 2000.

If the CardioMD acquisition software has never been installed on the PC, the FireWire driver must be installed.

Procedure	***Details***
1. Insert the CardioMD software CD in the acquisition PC's CD-ROM drive.	
2. Close all programs on the acquisition PC.	

Procedure	*Details*
3. Start the Windows Explorer and select the CD-ROM drive.	
4. Select the directory `Firewire driver version 1.5 for the stationary PC`.	
5. Run the file `ubCore.exe` by double-clicking on the name of the file.	
6. Follow the instructions given.	
7. After installing the driver, run the Fire-Viewer software to check that FireWire communication is working properly. Instructions are provided in Chapter 5 *Diagnostics*.	

Note. If you display the Device Manager (right-click the My Computer icon, select Properties, click the Hardware tab and then the Device Manager button), the icon `Unibrain driver/FireBoard400` (the name of the FireWire driver) is marked with a yellow Exclamation mark. In principle, this means that the device is not working properly. Reinstalling the FireWire driver does not solve the problem.

The reason for this is that there is a minor mismatch between Microsoft Windows 2000 and the FireWire driver used by the CardioMD acquisition software. However, this does not affect FireWire functionality. To ascertain that the FireWire communication between the gantry and the acquisition PC is working properly, run the FireViewer program that is installed along with the driver. See instructions in Chapter 5 *Diagnostics*.

III

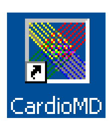
Installing the FireWire driver on Windows XP

Note. This section applies to acquisition PC's running Windows XP.

Procedure	*Details*
1. Insert the CardioMD software CD in the acquisition PC's CD-ROM drive.	
2. Close all programs on the acquisition PC.	
3. Start the Windows Explorer and select the CD-ROM drive.	
4. Select the directory `FireWire OHCI driver version 3.0 for laptop PC`.	
5. Run the file `ubCore3_23.exe` by double-clicking on the name of the file.	
6. Follow the instructions given.	
7. After installing the driver, run the Fire-Viewer software to check that FireWire	

Procedure	***Details***
communication is working properly. Instructions are provided in Chapter 5 *Diagnostics*.	

Installing the CardioMD Application Software

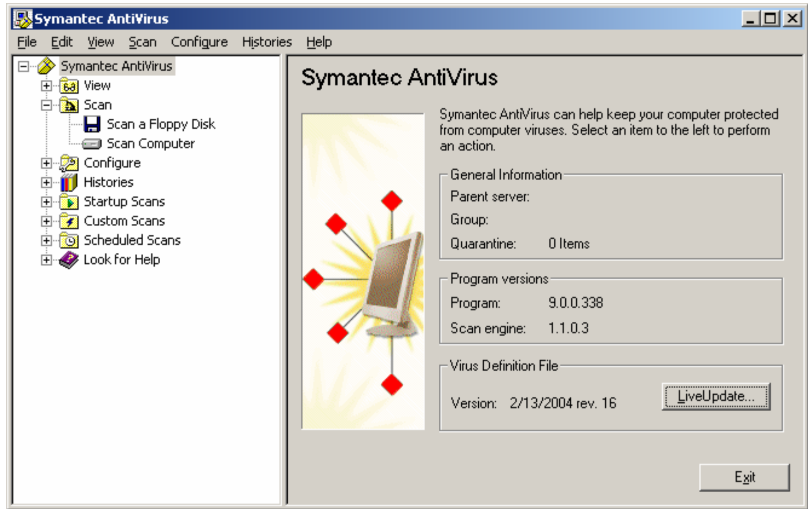
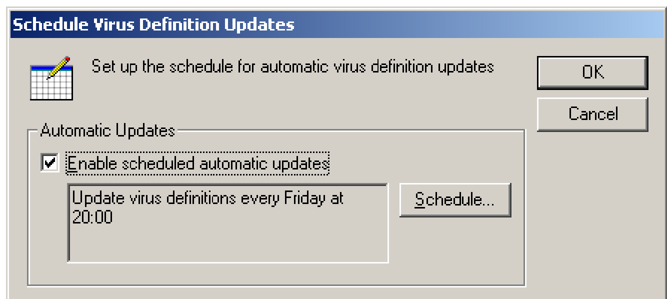
Procedure	***Details***
1. Insert the CardioMD software CD in the acquisition PC's CD-ROM drive.	
2. Close all programs on the acquisition PC.	
3. Start the Windows Explorer and select the CD-ROM drive.	
4. Run the file `InstallCardioMDtotal.bat` by double-clicking on the name of the file.	
The file is located in the root directory of the CD-ROM.	
5. Follow the instructions given.	
6. When the software installation is completed, restore calibration tables and customer specific protocols from the backup disks. Instructions are provided in the Appendix of the CardioMD Operator's Manual.	
7. Finally, remove the software CD-ROM and store it in a safe place along with the backup disks.	
8. Start the CardioMD acquisition software by double-clicking the CardioMD icon on the acquisition PC's desktop.	

7.3.3 Configuring Antivirus Software

III

Acquisition PC's running Windows XP (CardioMD Series III systems) are supplied with antivirus software. This section provides instructions for configuring Symantec AntiVirus™ on the acquisition PC.

If the CardioMD acquisition PC has no access to the internet or outside networks, you may want to prevent it from trying to automatically check for new antivirus updates through its LiveUpdate feature. To disable LiveUpdate, follow the instructions below.

Procedure	***Details***
1. In the Windows Start menu, select **Programs**, **Symantec Client Security** and **Symantec AntiVirus**. The Symantec AntiVirus window appears.	
2. Select **Schedule Updates** from the File menu. The window Schedule Virus Definition Updates appears.	
3. De-select the checkbox Enable scheduled automatic updates. This stops the AntiVirus software from running the LiveUpdate function. Alternatively, the Schedule button lets you tailor the automatic updates setup to suit individual needs at your installation. Refer to the Symantec AntiVirus Help for further information.	

7.4 Checking Installed Software Versions

When you have completed a software update, you can check the system log files to verify that the software on the CardioMD software installation CD you have been using has actually been installed on the system.

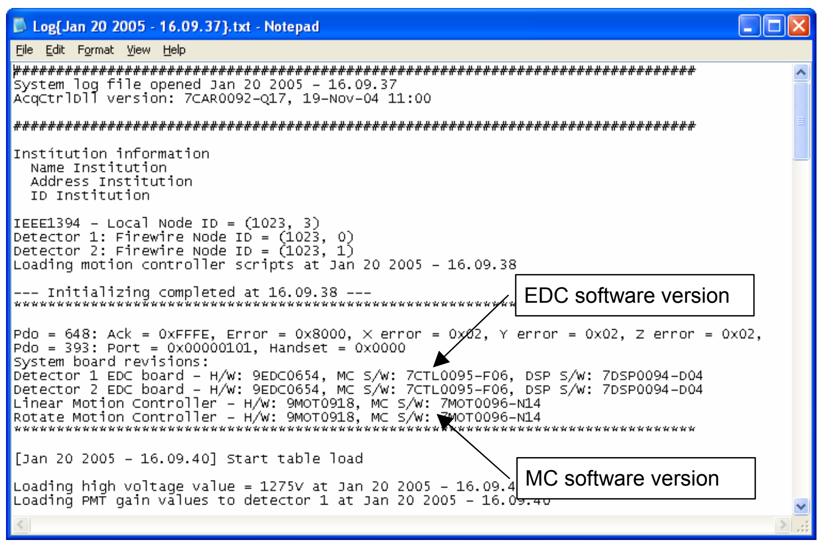
Procedure	***Details***

To check the version of the acquisition software (GUI – Graphical User Interface):

1. Check the version number in the upper left-hand corner of the CardioMD application window and compare it to the GUI version number indicated on the label of the installation CD-ROM and the release note.

2. Open the Windows Explorer.
3. In the directory `C:\cardiocam\SystemLog`, find the most recent log file.
4. Double-click the name of the log file to open it in the Windows Notepad program.

The contents of the log file will look similar to the file shown on the right.



5. Check the EDC software against the EDC software version indicated on the label of the installation CD-ROM.

   Look for the entry `MC S/W` – this is the EDC board microcontroller software version. You can safely ignore the entry `DSP S/W`.

6. Check the motion controller software (item `MC S/W`) against the MC software version indicated on the label of the installation CD-ROM.

Note. Both EDC boards must have the same software version. Likewise, both motion controllers must have the same software version.

8 INSTALLATION

Contents

8.1 Installation Requirements

8.1.1 Introduction

I, II III

This installation section describes the installation of CardioMD Series III system. Should you need to install a CardioMD Series I or II system, refer to Chapter 8 *Installation* of the service manual originally provided with the CardioMD Series I or II system.

Note. A few of the photos in this chapter actually show CardioMD Series I/II systems. This is the case only where these details of the system are insignificant for the installation procedure.

Note. Regardless of the system version, read the document *CardioMD Camera Site Planning*, part no. 9347-0112.

I, II

Note. Section 8.3.4 Software Setup on page 8-75 does provide some information on setting up software under Windows 2000, which is used on Series I and II systems acquisition PC's.

8.1.2 Ideal Floor Space Allocation

Some general considerations should be followed for all nuclear camera systems. These include comfortable workspace, good visual access to patients on the equipment, sufficient service access, and patient safety. All nuclear equipment contains components such as the sodium iodide crystals and high speed electronics that require reasonably well controlled temperature, humidity, and power.

Complete camera systems can be installed in a single room or with the gantry and acquisition station in one room and the processing station in a separate room.

8.1.3 Minimum Floor Space Allocation

Minimum floor space layouts are shown for the CardioMD system including processing station electronics.

The electronics do not require a separate environmentally controlled room, provided that the proper cooling and humidity ranges are available.

#	*Equipment*	*Width*	*Depth*	*Height*	*Weight*
1a	Gantry and table assembly* Incl. +/– 5 cm travel	112 inch 284 cm	58 inch 150 cm	58 inch 150 cm	1797 lbs. 815 kg
1b	Gantry and table assembly* Incl. +/– 5 cm travel	83 inch 210 cm	58 inch 150 cm	58 inch 150 cm	1797 lbs. 815 kg
2	Collimator cabinet	17 inch 43 cm	17 inch 43 cm	40 inch 102 cm	75 lbs. 33 kg
3a	Cart-mounted acquisition PC	25.2 inch 63.9 cm	25.4 inch 64.5 cm	47.3 inch 120 cm	66 lbs. 30 kg
3b	Wall-mounted acquisition PC	30.8 inch 79 cm	15.2 inch 39 cm	22.6 inch 58 cm	51 lbs. 23 kg
3c	Desk-mounted acquisition PC	22.8 inch 58 cm	15.0 inch 38 cm	11.8 inch 30 cm	10 lbs. 5 kg

* The CardioMD system is available in a standard configuration (1a) and a reduced room size version (1b)

Table 8.1 Minimum floor space allocation for the CardioMD system

#	*Equipment*	*Width*	*Depth*	*Height*	*Weight*
4	Jetstream Cardio (processing workstation placed on customer's desktop)	6.7 inch 17 cm	18 inch 46 cm	17.7 inch 45 cm	40 lbs. 18 kg
5	Jetstream Cardio Monitor (placed on customer's desktop)	16.7 inch 43 cm	9.3 inch 24 cm	16.1 inch 41.0 cm	19 lbs. 8.7 kg
6	PegBlade (processing workstation placed on customer's desktop)	18.0 inch 46 cm	18.0 inch 46 cm	5.0 inch 12 cm	27 lbs. 12 kg
7	PegBlade Monitor (placed on customer's desktop)	20.0 inch 51 cm	20.0 inch 51 cm	20.0 inch 51 cm	69 lbs. 32 kg
8	Codonics Printer (option, placed on customer's desktop)	17.0 inch 43 cm	21.0 inch 53 cm	12.0 inch 30.0 cm	55 lbs. 25 kg
9	Uninteruptible power supply (UPS, 2.2 kVA from APC, Inc.)	8.0 inch 20 cm	22.0 inch 56 cm	17.0 inch 43 cm	112 lbs. 51 kg
10	Uninteruptible power supply (UPS, 3.1 kVA from Best, Inc.)	20.0 inch 51 cm	35.0 inch 89 cm	35.0 inch 89 cm	450 lbs. 204 kg
11	Uninteruptible power supply (UPS, 5.0 kVA from Toshiba)	10.0 inch 26 cm	33.0 inch 84 cm	27.5 inch 70 cm	385 lbs. 175 kg

Table 8.2 Minimum floor space allocation for equipment connected to the CardioMD system

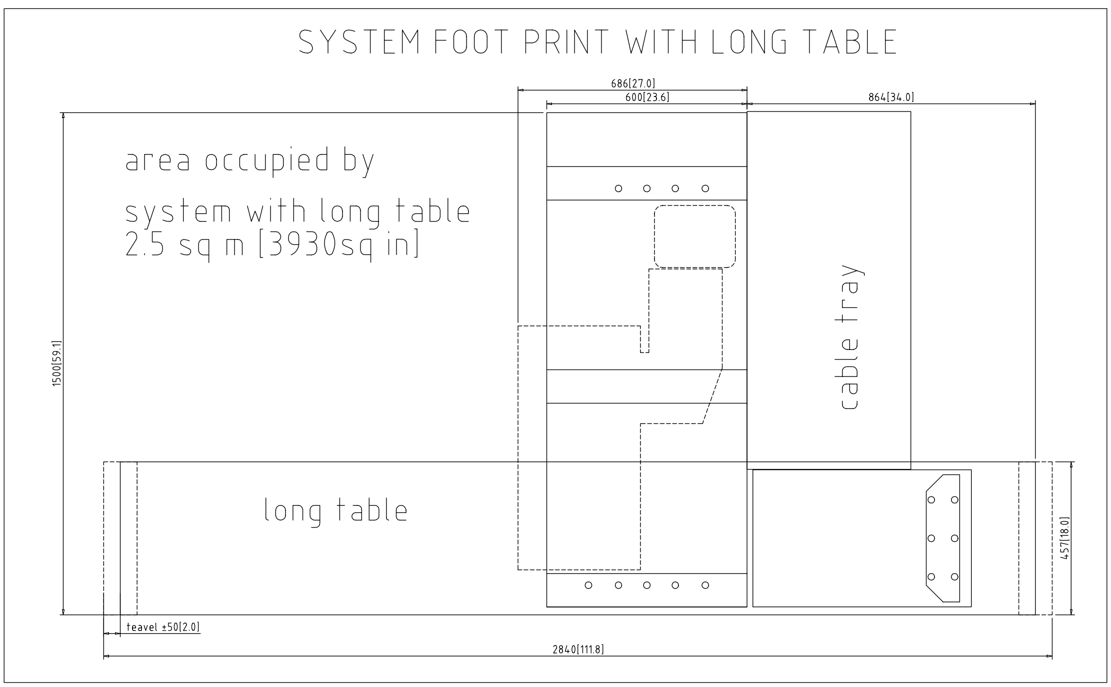


Figure 8.1 System footprint with long table

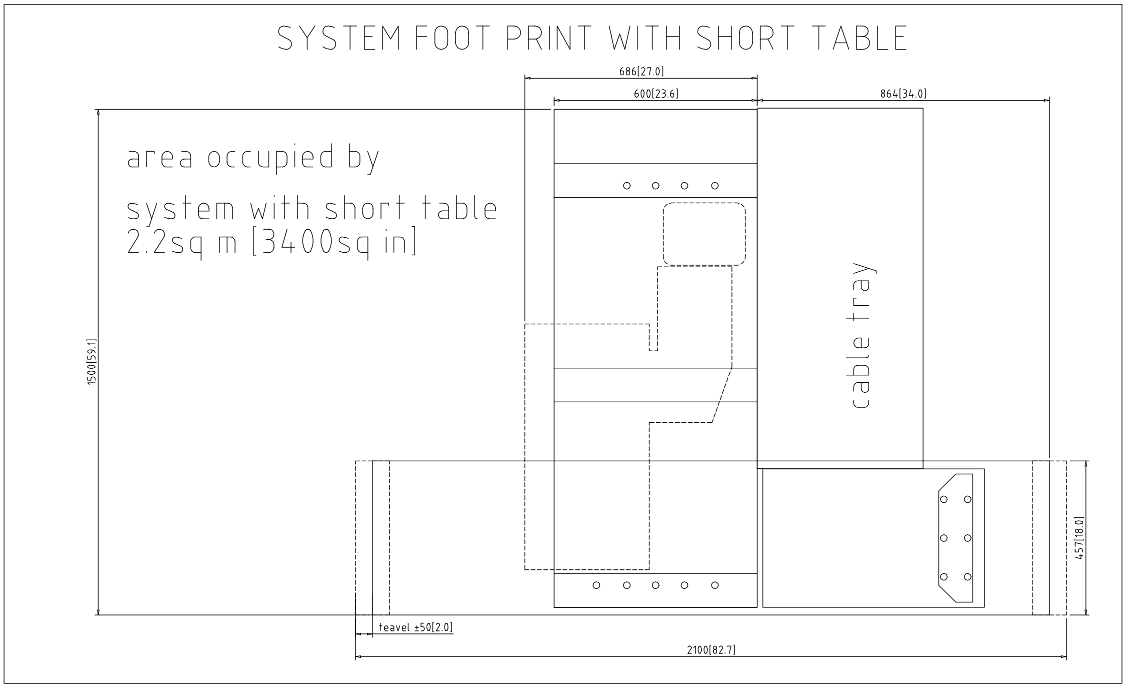
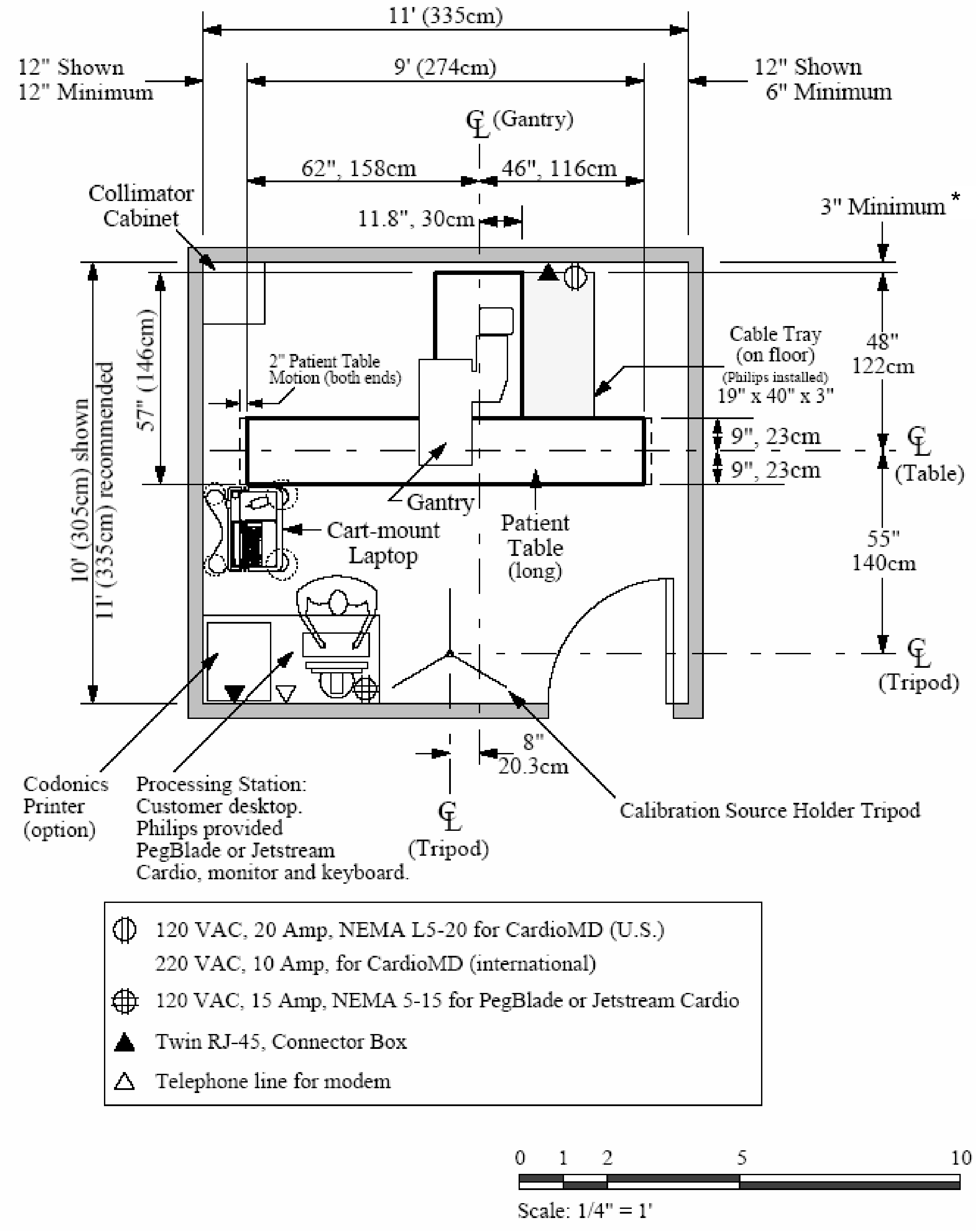
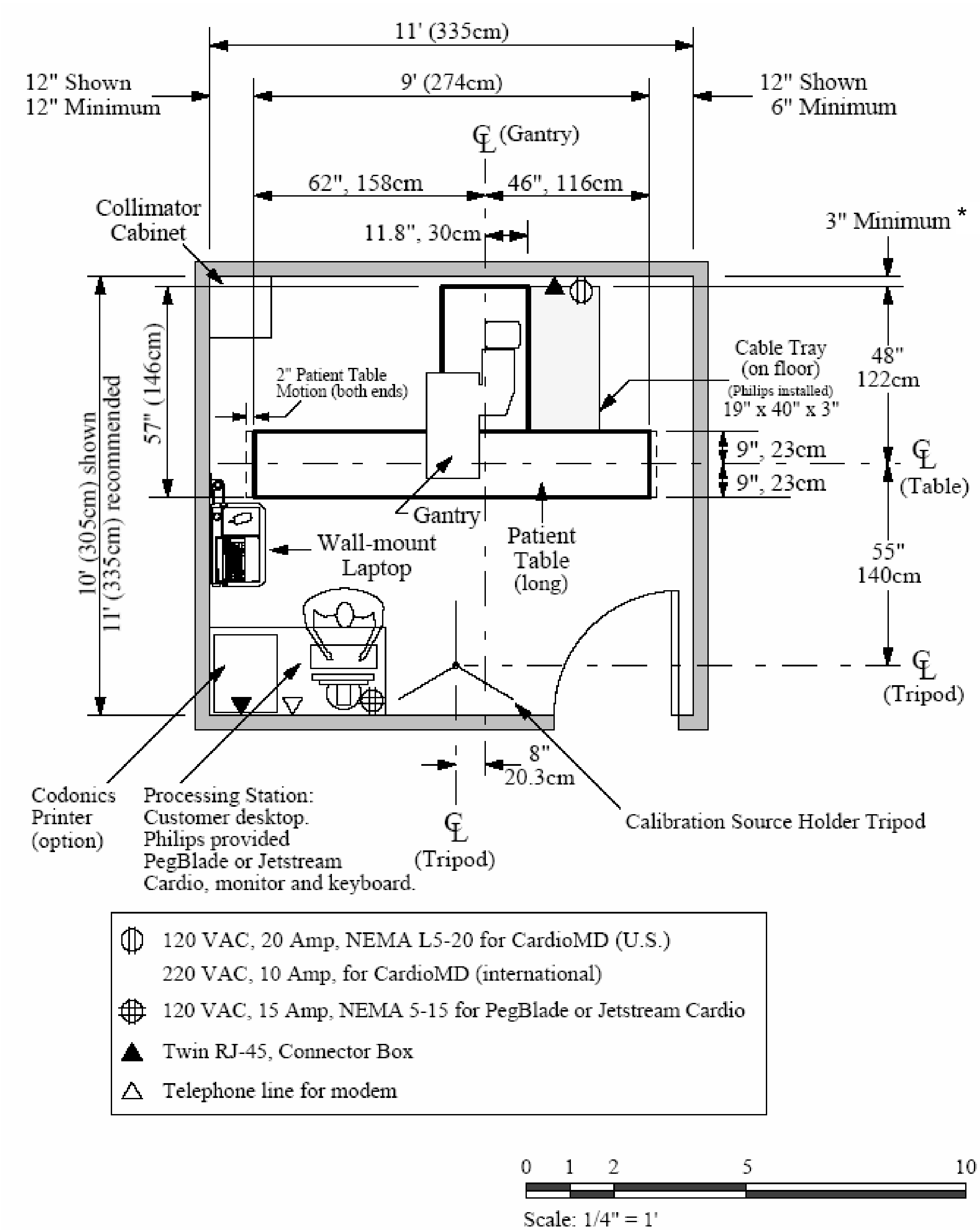


Figure 8.2 System footprint with short table



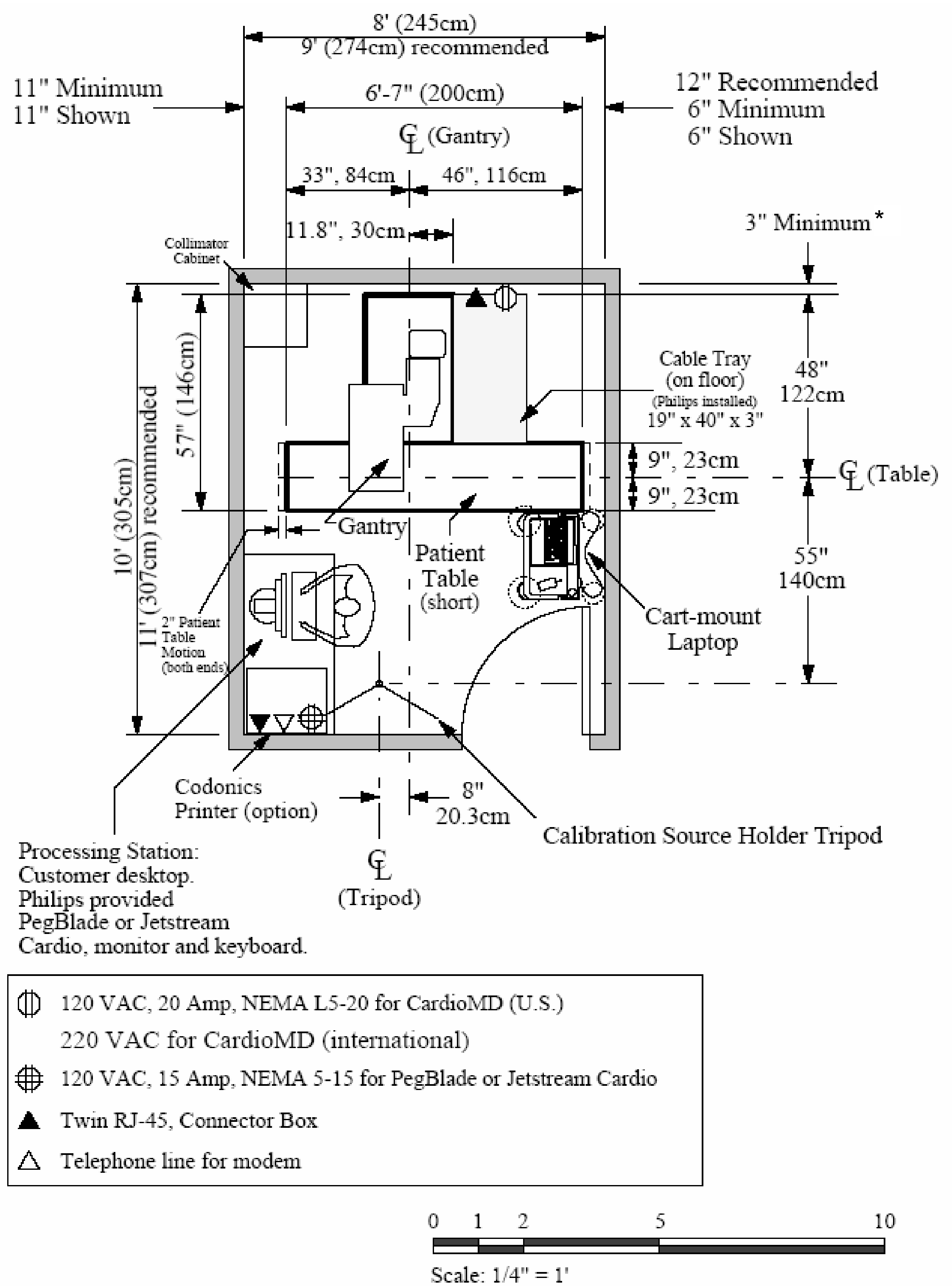
* **Note**. It is important that there is a minimum distance of 3" between the CardioMD camera and the wall. This space is needed for the point source holder used to calibrate the system when the CardioMD AC option is installed

Figure 8.3 Minimum room layout with long table and cart-mounted acquisition PC



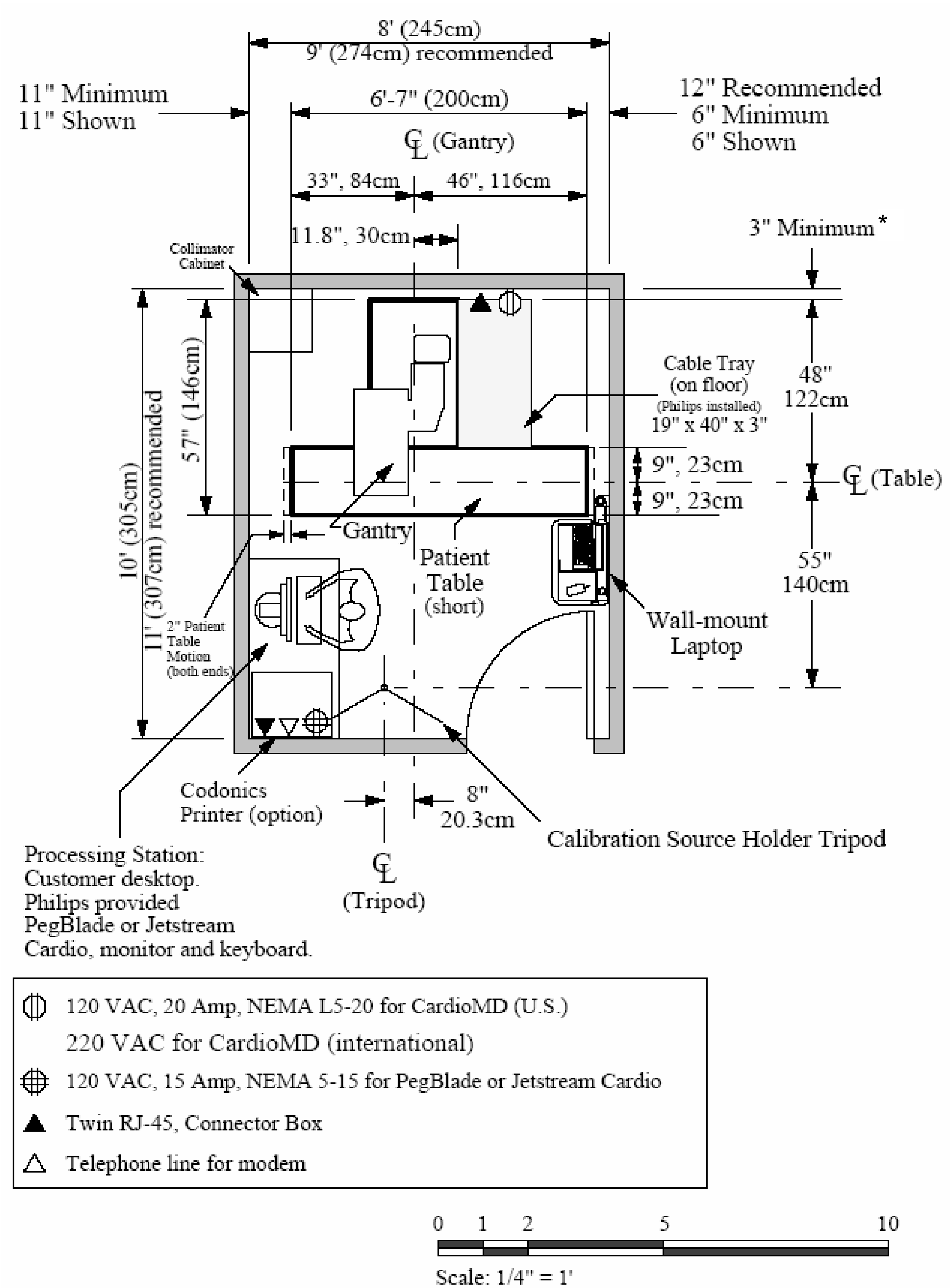
* **Note**. It is important that there is a minimum distance of 3" between the CardioMD camera and the wall. This space is needed for the point source holder used to calibrate the system when the CardioMD AC option is installed

Figure 8.4 Minimum room layout with long table and wall-mounted acquisition PC



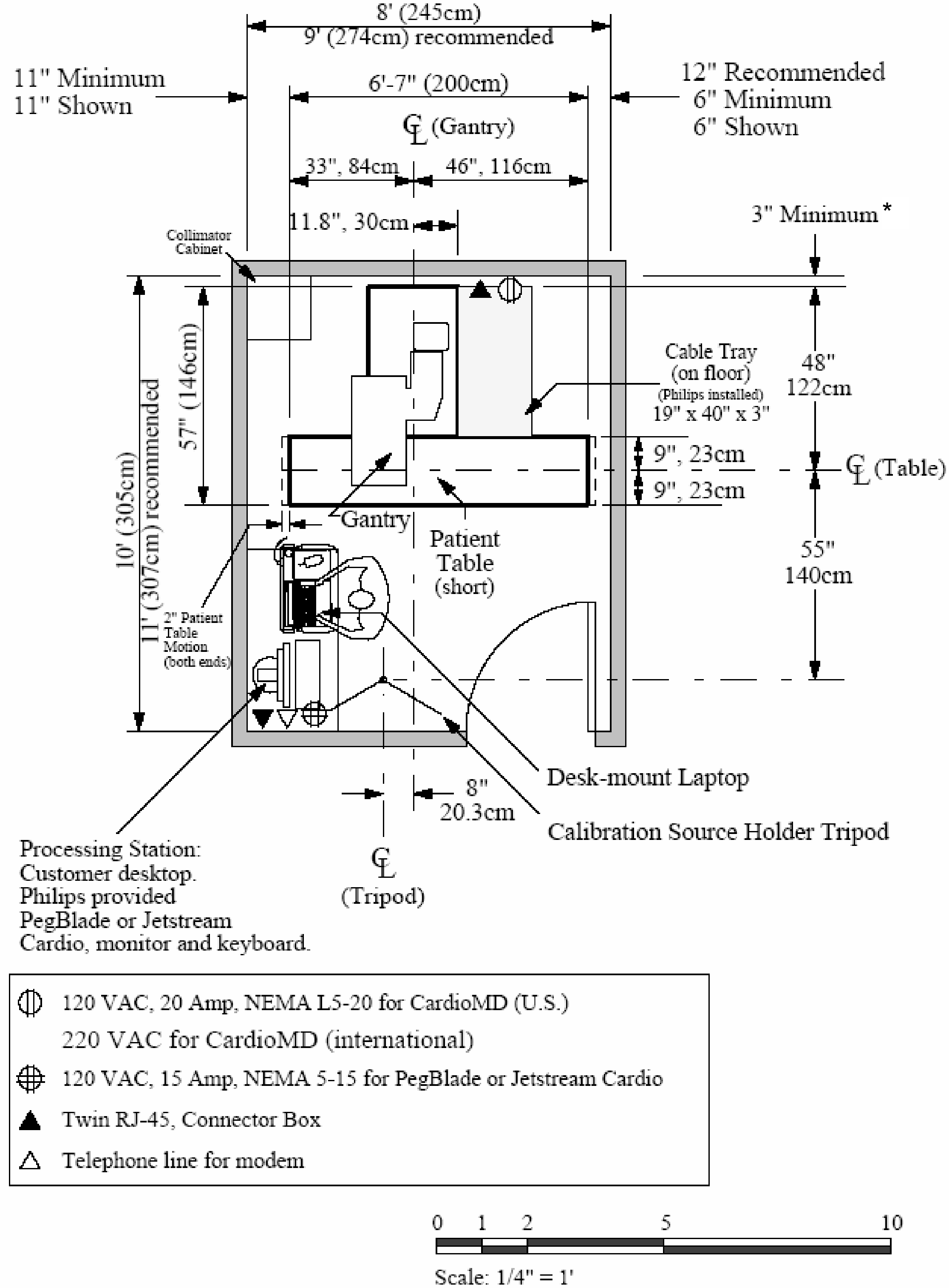
* **Note**. It is important that there is a minimum distance of 3” between the CardioMD camera and the wall. This space is needed for the point source holder used to calibrate the system when the CardioMD AC option is installed

Figure 8.5 Minimum room layout with short table and cart-mounted acquisition PC



* **Note**. It is important that there is a minimum distance of 3" between the CardioMD camera and the wall. This space is needed for the point source holder used to calibrate the system when the CardioMD AC option is installed

Figure 8.6 Minimum room layout with short table and wall-mounted acquisition PC



* **Note**. It is important that there is a minimum distance of 3" between the CardioMD camera and the wall. This space is needed for the point source holder used to calibrate the system when the CardioMD AC option is installed

Figure 8.7 Minimum room layout with short table and desk-mounted acquisition PC

8.1.4 Ceiling Height

To provide sufficient service access, permit NEMA standard flood testing, and allow for proper air circulation, the minimum allowable ceiling height should be 8’ 0” (245 cm) A/FF. 9’ 0” (275 cm) A/FF ceiling height is recommended. (A/FF signifies ‘above finished floor’.)

8.1.5 Ancillary Services

The ancillary services for the system should also be considered, when determining the floor space allocation. This would include areas such as:

- Reception/waiting room
- Darkroom
- Hot lab
- Storage
- Dressing rooms
- Toilets
- Physician’s office, etc.

8.1.6 Miscellaneous

8.1.6.1 General

While planning the site, keep in mind that storage space for supplies, such as linens, on-site spare parts, film, medical supplies, etc., is needed.

8.1.6.2 Floor

The room floor must consist of a finished concrete floor covered with an industrial-grade anti-static tile. No carpet may be used on the floor.

8.1.6.3 Lighting

Lighting fixtures, vents, etc. shall be flush with finished ceiling.

Dimmers should be used to control light levels in control and exam rooms. Locate dimmers conveniently for gantry and controls.

8.1.6.4 Housekeeping

Housekeeping rules, which should be observed in the nuclear room, include:

- Never use steel wool for cleaning in any of the rooms. The fine metal fibers can enter enclosures via air cooling systems and cause internal short circuits that are difficult to detect and correct, causing equipment downtime.
- Buffing of wax on floors can circulate a fine powder which could collect inside the components on open contacts. Consequently, only liquid waxes should be used.

Note. Past experience indicates that it is advantageous to install a sink in the nuclear room.

8.1.7 Environment

8.1.7.1 RFI Considerations

Hospitals' surrounding conditions, internal and external to building structures, may cause radio frequency interference. These problems are sometimes derived from high wattage transmitters such as: TV station, radio station, or other nearby transmitters.

Many RFI problems are difficult to define and may require an analysis from an outside specialist or consultant in this field, hired by the customer.

8.1.7.2 EMI Considerations

The main power lines of the system should be dedicated lines directly from the nearest hospital main distribution transformer. It is advised that no other electrical equipment be connected to these power lines now or in the future.

HV transformer equipment, electric meters, and other electro-magnetic devices may cause interference to the microprocessor and computer equipment and should not be located adjacent to the camera room.

8.1.7.3 Gamma Events

The camera detects gamma events from a radioactive source and measures their intensity. Hospital physicists must consider this when a hot lab or patient waiting area is located adjacent to a camera room. Consideration must also be given to new equipment layout with respect to current gamma cameras.

Note. The CardioMD system is designed for low energy imaging and the detector is shielded accordingly for up to 170 keV only.

8.1.7.4 Magnetic Fields

The camera is adversely affected by magnetic fields produced by MRI equipment, transformers, etc. The camera must not be located within a field > 0.5 gauss. Distance will depend on magnet field strength, shielding and technology being applied.

8.1.8 Safety

It is suggested that oxygen and suction services be provided in the examination room convenient for the gantry. These services may be of portable or permanent type.

Fire protection for the type of equipment and systems specified shall be provided in accordance with local codes.

8.2 Shipping, Handling, Installation and Storage

8.2.1 Shipping Containers and Weights

Prior to installation, either the customer or a structural engineer must qualify that the proposed room location is capable of supporting a CardioMD system. Furthermore, the entire equipment path from the receiving dock to the clinical room must also be qualified. This includes all freight elevators if applicable.

The system is shipped with either a short or a long patient table in 6 containers. Table 8.3 lists size and weight.

Shipping box with	***Shipping weight***	***Size W × D × H***
Gantry incl. detector and collimators	1653 lbs. 750 kg	34 × 61 × 63 inch 86 × 155 × 160 cm
Table base	507 lbs. 230 kg	31,5 × 47.2 × 36,6 inch 80 × 120 × 93 cm
Accessories, laptop PC, covers, dolly etc.	397 lbs. 180 kg	31,5 × 57 × 34,3 inch 80 × 145 × 87 cm
Option: Short table and mattress	35 lbs. 16 kg	19,7 × 81.5 × 5.9 inch 50 × 207 × 15 cm
Table support for short table option	66 lbs. 30 kg	31.5 × 23.6 × 31.5 inch 80 × 60 × 80 cm
Option: Long table and mattress	44 lbs. 20 kg	19.7 × 110.6 × 5.9 inch 50 × 281 × 15 cm
Table support for long table option	66 lbs. 30 kg	31.5 × 23.6 × 31.5 inch 80 × 60 × 80 cm
Laptop cart-mount option	110 lbs. 50 kg	31.5 × 47 × 37 inch 80 × 120 × 93 cm
Laptop wall-mount option	110 lbs. 50 kg	19.7 × 110.6 × 10.6 inch 50 × 281 × 27 cm
Laptop desk-mount option	110 lbs. 50 kg	19.7 × 110.6 × 10.6 inch 50 × 281 × 27 cm
Collimator cabinet	110 lbs. 50 kg	18.9 × 43.3 × 22.4 inch 48 × 110 × 57 cm
AC Option	122 lbs. 55 kg	15.7 × 31.5 × 25.6 inch 40 × 80 × 65 cm

Table 8.3 Shipping containers, contents, weight and dimensions

8.2.2 Passageway Clearances

Check all doors, corridors and elevators to ensure adequate clearances for the moving of the equipment.

The primary method for transporting the CardioMD gantry and table base from the receiving dock to the clinical room is a special dolly supplied with the system. A standard pallet jack best transports the table and remaining packages.

Below are listed the minimum passage clearances required for moving a CardioMD system.

8.2.2.1 Equipment Moved in Boxes on Pallet Jacks

Door width	62 inch (150 cm)
Corridor width (90° angle)	67 inch (175 cm)
Door height	80 inch (200 cm)
Elevator width (if required)	62 inch (150 cm)
Elevator depth (if required)	55 inch (140 cm)
Elevator height (if required)	80 inch (200 cm)

Table 8.4 Passage clearances for moving equiment in boxes on pallet jacks

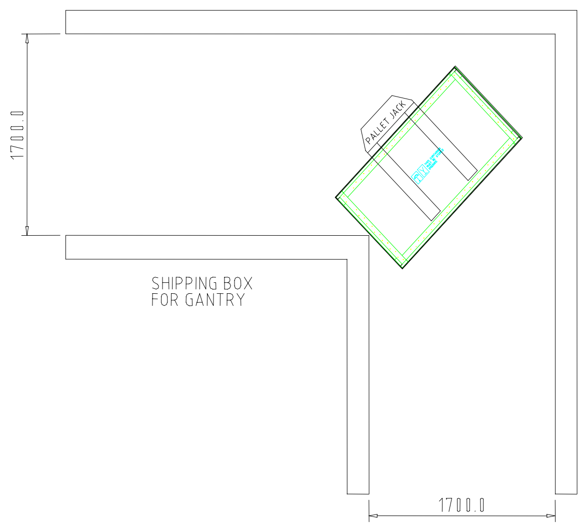


Figure 8.8 Minimum clearance for turns

8.2.2.2 Equipment Moved on Dolly Shipped with the System

Door width (with/without jack beams mounted)	36 inch (91 cm) / 30 inch (75 cm)
Corridor width (90° angle)	42 inch (105 cm)
Door height	80 inch (200 cm)
Elevator width (if required) (with/without jack beams mounted)	36 inch (91 cm) / 30 inch (75 cm)
Elevator depth (if required)	60 inch (150 cm)
Elevator height (if required)	80 inch (200 cm)

Table 8.5 Passage clearances for moving equipment on dolly

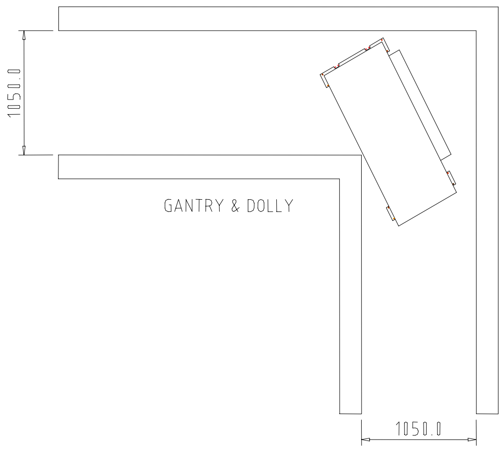


Figure 8.9 Minimum clearance for turns

8.2.3 Equipment Storage

If the equipment is to be stored by the customer prior to installation, the storage facility housing the equipment must be dry and be kept at a constant temperature. The storage facility should be regulated between 50° F and 86° F (10° C and 30° C), have a relative humidity between 45% and 80%, and have a dust-free environment. 55% relative humidity is recommended.

WARNING

The detector crystal assemblies are extremely fragile and sensitive to sudden changes in temperature. The detector heads are thermally protected within the gantry-shipping container. Collimators are also mounted and shipped on the detectors providing additional thermal protection. The thermal protection controls the temperature change rate of the crystals.

CAUTION

Caution. You must never remove this thermal protection before the detectors have been in a controlled environment and the detectors have reached room temperature. It is suggested that the detector temperature is allowed to stabilize for a period of 24 hours with the thermal protection still on the detectors, in instances where the equipment is being relocated from one temperature to an extremely different temperature environment.

The accepted rate of change should be less than 15° F (8° C) per hour. Do not locally heat or cool the detector so as to produce gradients greater than 5° F (3° C) across the detector face. Failure to comply may result in breakage of the detector crystal.

8.2.4 Power Requirements

8.2.4.1 Quality of Power

Power quality specifications are based on measurements taken at the nuclear room power distribution panel.

8.2.4.2 Transient Voltage

> 240 V	None allowed
180-240 V, < 100 µsec	1/day max
90-180 V, < 400 µsec	6/hr, 24/day max
50-90 V, < 800 µsec	6/hr, 24/day max

Table 8.6 Transient voltage tolerances

Note. If transients on the line exceed specified tolerances, a transient suppressor is recommended to prevent equipment damage.

8.2.4.3 Voltage Regulation

All combinations of line variation shall not cause the line-to-line or line voltage to deviate from either its nominal or average value by more than 7 %, whichever is less. For example, assuming a nominal voltage of 120 V, if the line sags below 111 V or surges above 128 V, an UPS line conditioner is required. The need for UPS is covered in the section 8.2.4.4.

8.2.4.4 Brownouts

If there are consistent voltage losses exceeding a 30 % drop in peak voltage for more than 5 cycles, a battery uninterrupted power supply (UPS) is recommended. Uninterruptible power supplies allow at least the case in progress to be completed and should be considered where there is concern for periodic power loss from any cause (line drop-out, generator testing, etc.) of the magnitude mentioned. The UPS also has significant benefit in that patient studies are not lost in the event of power failure or generator test.

8.2.4.5 Source Configuration

The power source supplying CardioMD system shall be single phase, neutral plus dedicated/ isolated ground (3-wire).

Nominal AC Volts	100, 120, 200, 220 or 240
Line Phase	Single
Full Load kVA	1.4 kVA
Line Amps	12 A (100 – 120 V), 6.25 A (200 – 240 V)
Voltage Variation	+10% – 10% from nominal

Table 8.7 Power source configuration

8.2.4.6 Emergency Power

Emergency power is not necessary for CardioMD systems since the procedure being performed at the time of the power failure would be lost anyway (unless the system is connected to an uninterruptible power supply). An UPS is strongly suggested for each CardioMD system.

8.2.5 Environmental Specifications

The temperature in the examination room must be regulated at 59° F to 86° F (15° C to 30° C). The humidity must be regulated at 45 to 80 % relative humidity (non-condensing). 55 % relative humidity is optimum. The tables below indicate the heat dissipation of the components of the CardioMD system.

CardioMD system	*Jetstream Cardio (optional)*		*PegBlade (optional)*	
	CPU	*Monitor*	*CPU*	*Monitor*
2,360 BTU/hr 165 Cal/sec 691 watts	1,400 BTU/hr 98 Cal/sec 410 watts	136 BTU/hr 10 Cal/sec 40 watts	854 BTU/hr 60 Cal/sec 250 watts	544 BTU/hr 38 Cal/sec 159 watts

Table 8.8 Heat dissipation of CardioMD system components

2.2 kVA (APC Inc., optional)	*3.1 kVA (Best Inc., optional)*	*5.0 kVA (Toshiba, optional)*
275 BTU/hr 19 Cal/sec 80 watts	742 BTU/hr 52 Cal/sec 217 watts	2,610 BTU/hr 183 Cal/sec 765 watts

Table 8.9 Heat loads for the UPS options

8.2.6 Networking and Cables

8.2.6.1 Networking

There are two general types of CardioMD networking installations:

1. Single camera/computer
2. Multiple camera/computer.

Single Camera/Computer

In a single camera/computer installation, Philips Medical Systems will network together the CardioMD system, the PegBlade computer and a printer.

The customer is responsible for providing one twin RJ-45 connection box near the CardioMD system and one near the PegBlade. The customer also needs to run Cat 5 cables in the walls, ceilings, or floors between the connection boxes.

If the customer does not provide the connection boxes and does not run the Cat 5 cables in the walls, Philips will run those cables along the floor. That may be unsightly if the connection boxes are far apart.

Multiple Camera/Computer

In a multiple camera/computer installation, Philips Medical Systems will network together the CardioMD system, the PegBlade computer and perhaps a printer and other networked devices. Other networked devices could be other CardioMD cameras, other Philips cameras, a hospital network, a network printer or a network viewing station as shown in the examples in Figure 8.10 on page 8-18.

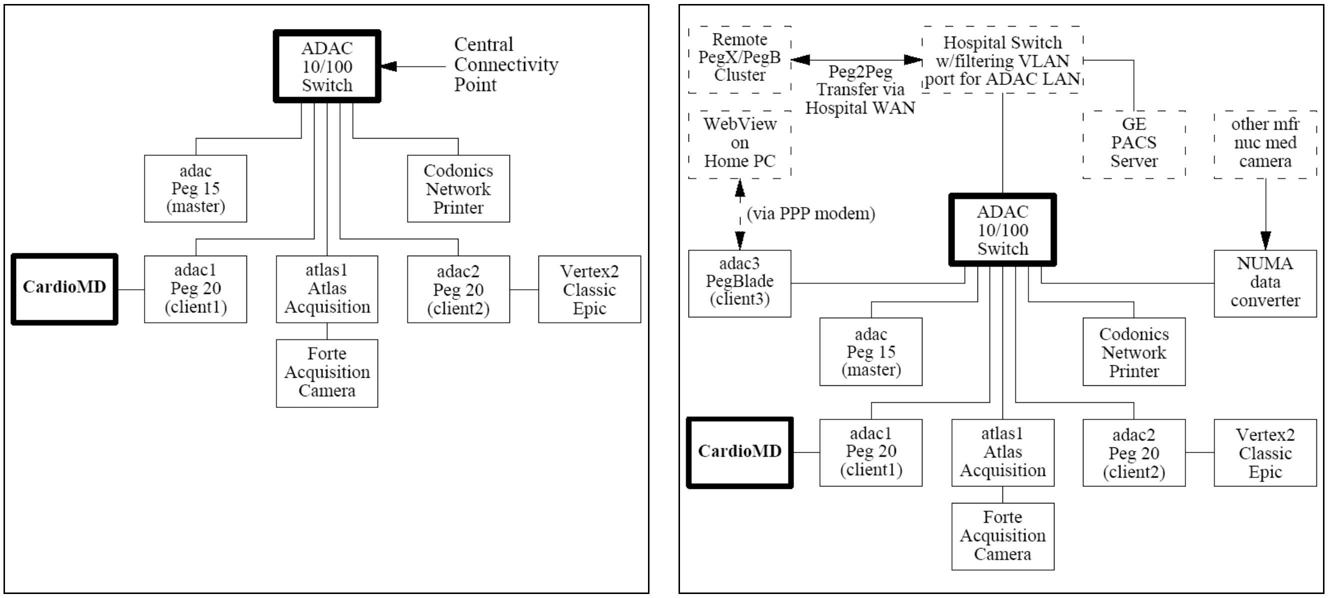
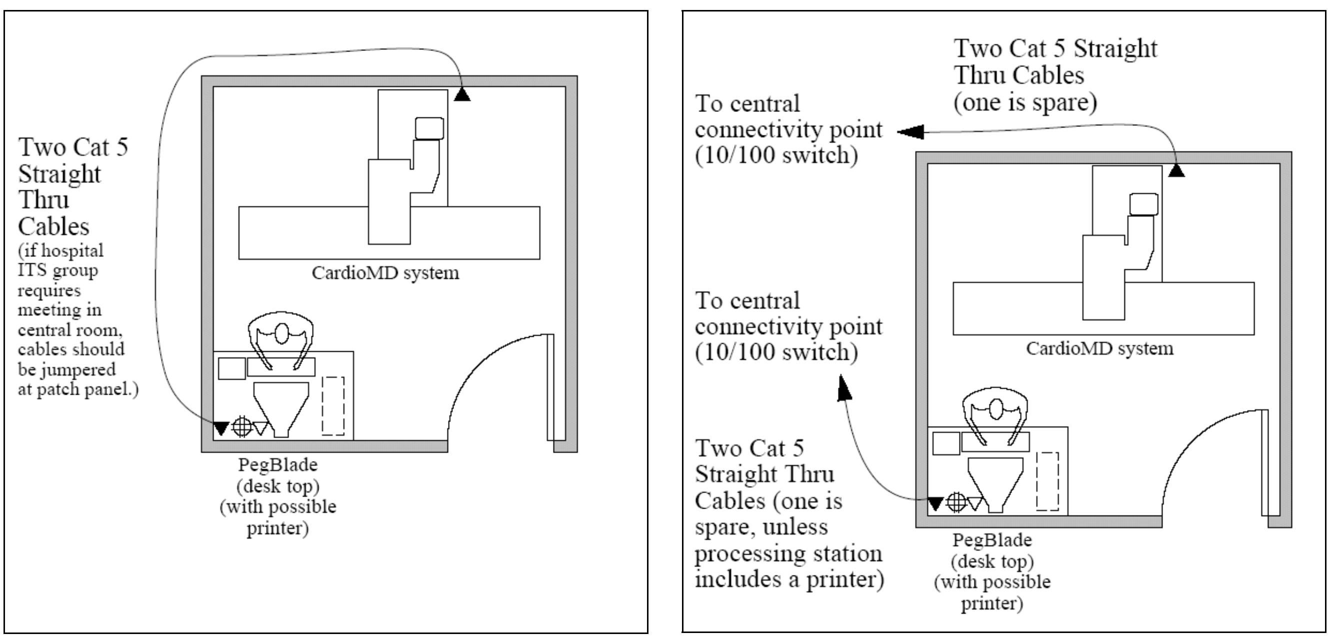


Figure 8.10 Multiple camera/computer installations

In a multiple camera/computer situation, the customer must install the twin RJ-45 connector boxes near the CardioMD system and near the PegUltra.

The customer must also run Cat 5 cables from the two connector boxes to a central connectivity point before ADAC can connect to other devices. See Figure 8.11.



Single camera/computer network

Multiple camera/computer network

Figure 8.11 Single and multiple camera/computer networks

8.2.6.2 Cabling

The length of the CardioMD power cord is 4 m (13 ft).

The acquisition PC cable comes from the right-hand side of the table console. The length of this cable depends on the acquisition PC option: Cart-mount, wall-mount or desk-mount.

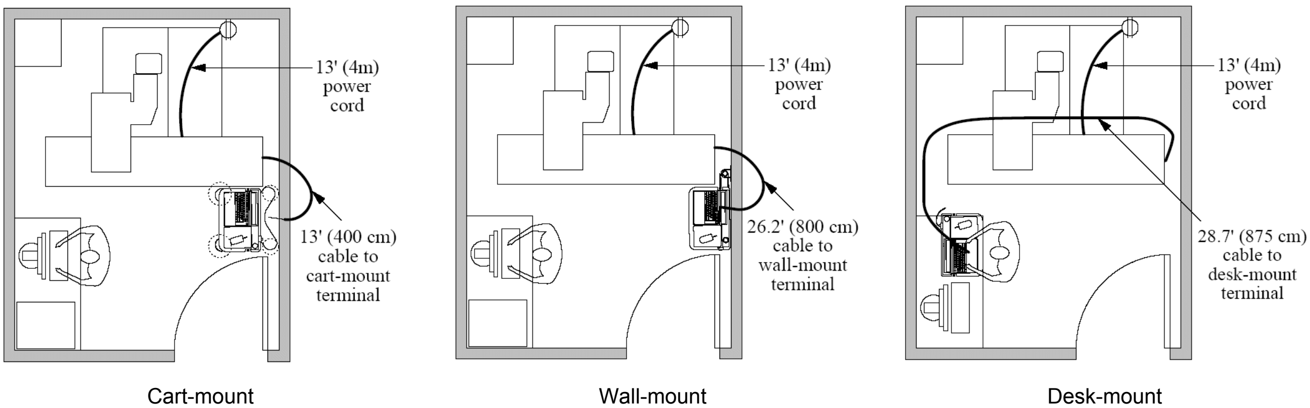


Figure 8.12 Acquisition PC and gantry cable lengths

8.2.7 CardioMD Floor Levelness

The floor occupied by the CardioMD system must be in level within ½ inch (12.5 mm).

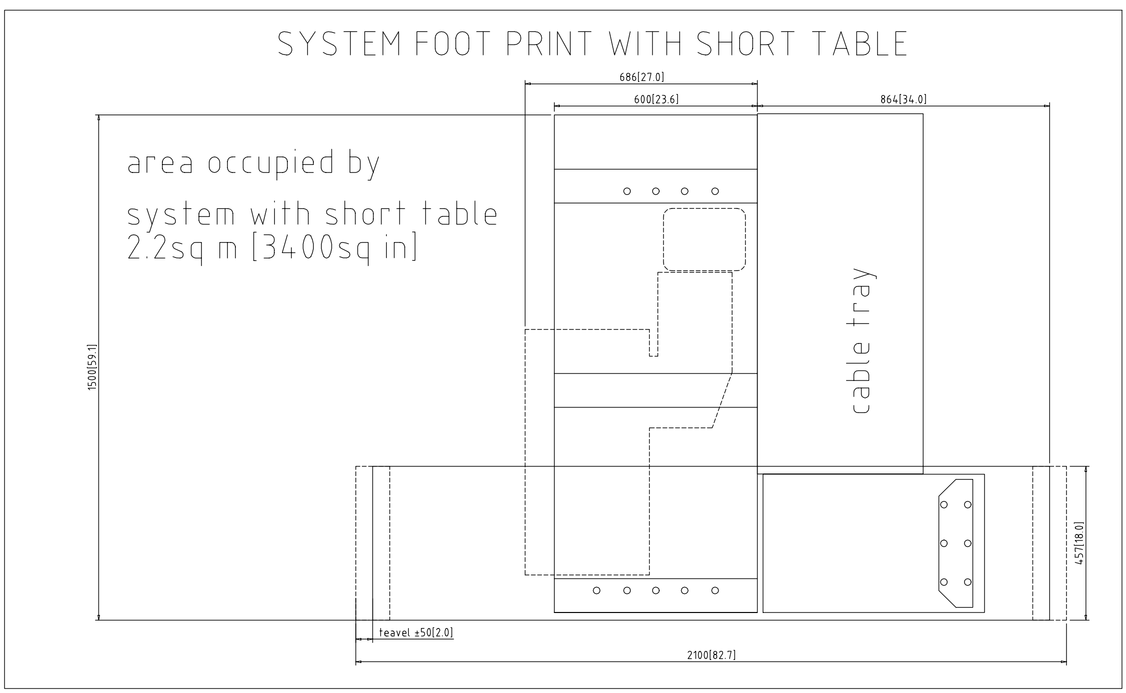


Figure 8.13 System footprint with short table

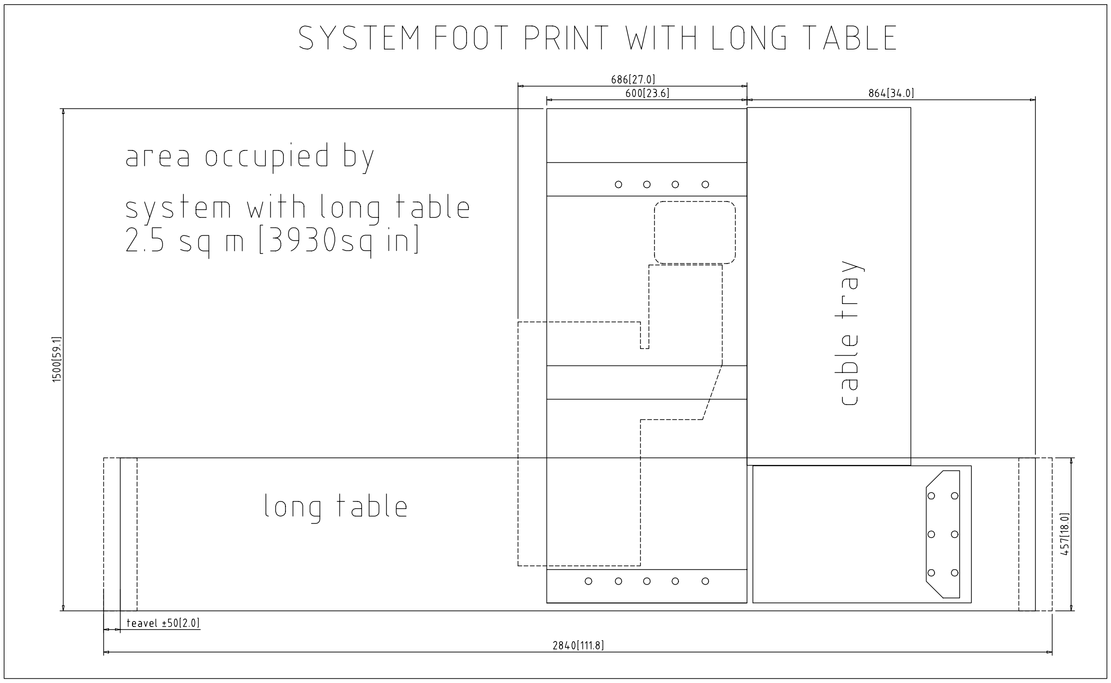


Figure 8.14 System footprint with long table

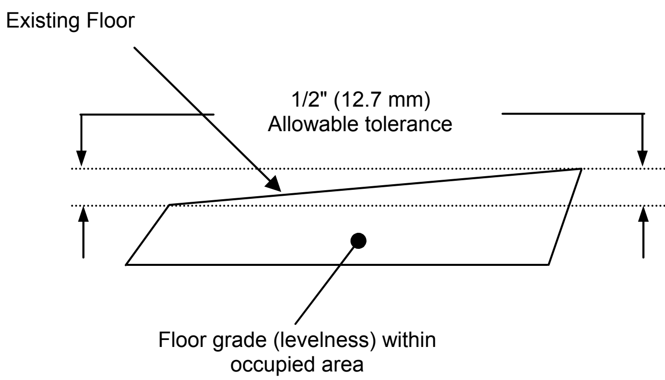


Figure 8.15 Floor levelness requirement

8.3 Installation

This section describes the steps to install the CardioMD nuclear gamma camera system. It is important that you understand the wide scope of this installation procedure before attempting to install a CardioMD system.

Note. Seismic (OSHPD) installation requires the optional seismic installation kit.

The CardioMD system is shipped with gantry and detectors assembled in one plywood box. A second plywood box contains the table console and a third plywood box contains the acquisition PC, dolly system, covers, cables and accessories.

The patient table options are shipped in two boxes, one containing the table pallet and mattress and one containing the table end support.

The acquisition PC option is shipped in a separate box, as well.

The processing station and other accessories provided by Philips Medical Systems are shipped separately.

The installation process comprises three main tasks. These tasks are spread out over a two-day period to allow time for the detectors to warm up and stabilize before system calibration and performance checking:

1. Gantry unload
2. Installation
3. System check-out.

8.3.1 Installation Overview

Note. Before starting an installation, make sure to study the document *CardioMD camera site planning*, ADAC no. 9347-0112.

Installation involves the following main steps:

1. Open the boxes and remove packing materials. Leave the detector insulation in place.
2. Remove the wooden end bars on the pallet and the shipping brackets (2 small and 1 large one).
3. Remove the gantry-shipping pallet using the jack beams. Remove front and rear mounting plates and replace them with the dolly wheels. Lower the gantry onto the wheels and remove the jack beams if needed for passing narrow doors.
4. Determine actual position of system using the template shipped with the equipment, and tape template to floor.
5. Drill holes using the template. Insert the expansion anchors and set the anchors using a mandrel.
6. Use the dolly wheels to transport the gantry to the installation room. Position the gantry. Mount the jack beams (if they were removed), jack up and dismount the dolly wheels.
7. Position the 2 mounting plates and mount 4 of the 6 M12 × 30 anchor screws and washers shipped with the system. Make sure that the side with countersunk around the M10 hole is pointing upwards. Do not tighten the bolts.

8. Position the gantry and lower the jacks. The gantry will be guided into the plates for the last 12 mm. Make sure that the gantry can be mounted to the plates with 4 pcs. M10 screws (2 in each end bar).
9. Insert the neoprene weather strip between the outside edge of the gantry frame and the floor, to prevent dirt from entering underneath gantry.
10. Using the dolly wheels, build trolley to transport the table base to the installation room..
11. Using the jack beams mounted to the table base, remove the pallet and lower table base on top of trolley. Remove the jack beams, if needed, for narrow doors.
12. Transport the table base to the installation room. Place it close to its final position. If the jack beams were removed, remount them, jack up and move the trolley away.
13. Lower the table base and remove the front jack beam leaving the rear end on the dolly beam about 25 mm (1 inch) above the floor. Place one of the protective plastic feet under the front end (close to the gantry) and mount 2 long bolts through the gantry frame as guide.
14. Push the table base in position. The table base is guided the last 5 mm by a key. Remove the long bolts and mount the table base to the gantry with 2 screws, one at the time. Tighten the screws and then loosen them by half a turn. Lower the rear end and remove the jack beam.
15. Mount the last 2 M12 × 30 anchor screws and washers in the rear end of table base and tighten. Tighten the 4 anchor screws in the mounting plates for the gantry.
16. Remove 4 mounting screws in the gantry (2 in each end bar) Using the special tool on the leveling screws and a spirit level, align the gantry to be level in horizontal plane. Remount the 4 screws and tighten.
17. Remove the 2 screws in the middle of the side bar and adjust the leveling screws. Remount the 2 screws and tighten.
18. Remove the 2 mounting screws in the table base rear end and align the cradle to be in level. Remount the 2 screws in the rear end.
19. Tighten the 2 screws holding the gantry and table base together. Remove the 2 shipping locks for the x-axis.
20. Mount the table support to the left sidebar of the gantry base.
21. Connect the 3 cables from the gantry to the table base.
22. Assemble and mount the acquisition PC option and cable it to the gantry. Connect the hand controller.
23. Configure input voltage selection; connect power and power up the system.
24. Tighten rear anchor bolts. Using the hand controller, move all axes. Leave the detector in upper position.
25. Remove the detector insulation (after 24 h of constant temperature).
26. Mount patient table pallet and mattress.
27. Check motion limits.
28. Mount stays for base cover.
29. Mount covers.
30. Set up and connect ECG gate.

31. Protect cables on the floor.
32. Perform local area network and DICOM setup.
33. Configure regional settings, institution name and units for patient height and weight.
34. Set up hardcopy printer.
35. Verify proper operation and detector performance.
36. Recalibrate detector if found required when checking performance (see Chapter 4 *Calibration*).
37. Acquire customer requested uniformity correction tables, etc.

8.3.2 Tools

8.3.2.1 Tools Shipped with System

- 2 dolly wheel bars
- 2 jack beams
- 4 plastic protection feet
- 4 socket head cap screws M12 × 75 mm
- 1 rectangular plywood plate (plate for trolley) 24 × 24 inch (60 cm × 60 cm)
- 1 ½" ratchet
- 1 leveling tool (special screw driver for the leveling screws)
- 2 M10 × 200 mm long bolts
- 1pcs 15 mm masonry drill.

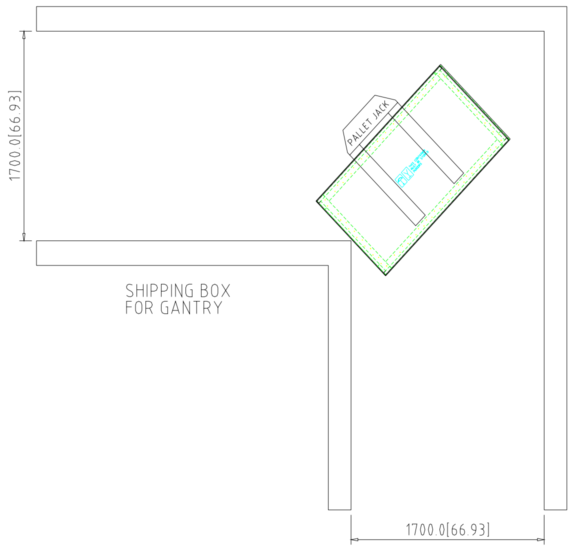
8.3.2.2 Tools not Shipped with System

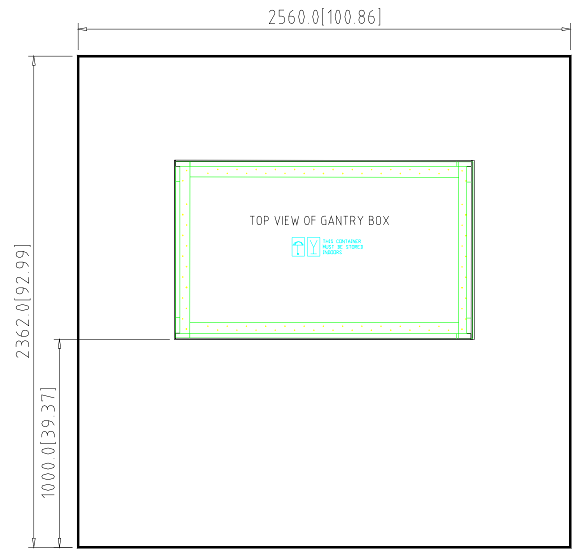
- Pallet Jack
- Spirit level with tolerance +/– 0.05°
- Hammer drill
- Metric Allen keys, 1.5 through 10 mm
- 3/8" drill with Phillips heads bit (used for disassembling shipping containers)
- Phillips screwdriver
- 3 mm standard screwdriver
- A set of Torx keys in the range of T6 – T25
- Wrenches: 16 mm, 17 mm and 19 mm
- Mandrel used to set the anchors.

8.3.3 Installation Procedure

8.3.3.1 Unpacking

Move the crate as close to the place of installation as the access permits, still having workspace to unload around it.





If corridors have a 90° corner, the corridor must be at least 67 inch (175 cm) wide

Required work space for unpacking and unloading: 100 x 92 inch (256 x 236 cm)

Figure 8.16 Minimum workspace and corridor width

Procedure	*Details*
The gantry is shipped in a wooden crate (34 × 61 × 63 inch / 86 × 155 × 160 cm). 1. Remove the plywood sides and top of the crate. 2. Remove the protection bag by carefully cutting around the edges.	 

Note. Leave the detector insulation in place at this point.

Procedure	***Details***

The table base is shipped in a second wooden crate (31.5 × 47.2 × 36.6 inch / 80 × 120 × 93 cm).

3. Remove the plywood sides and top.
4. Remove the protection bag by carefully cutting around the edges.

The acquisition laptop PC, system accessories, covers and installation Dolly are all shipped in a third wooden crate (31.5 × 57 ×34 inch / 80 × 145 × 87 cm).

5. Remove the plywood sides and top.
6. Remove the protection bag by carefully cutting around the edges.

The patient table option is shipped in two cardboard boxes.

The pallet and mattress are shipped in one box:

- 19.7 × 110.6 × 5.9 inch / 50 × 281 × 15 cm for the long table,
- 19.7 × 81.5 × 5.9 inch / 50 × 207 × 15 cm for the short table.

The table end support is shipped in a second box (31.5 × 23.6 × 31.5 inch / 80 × 60 × 80 cm).

7. Open the boxes and remove the protection bags by carefully cutting around the edges.

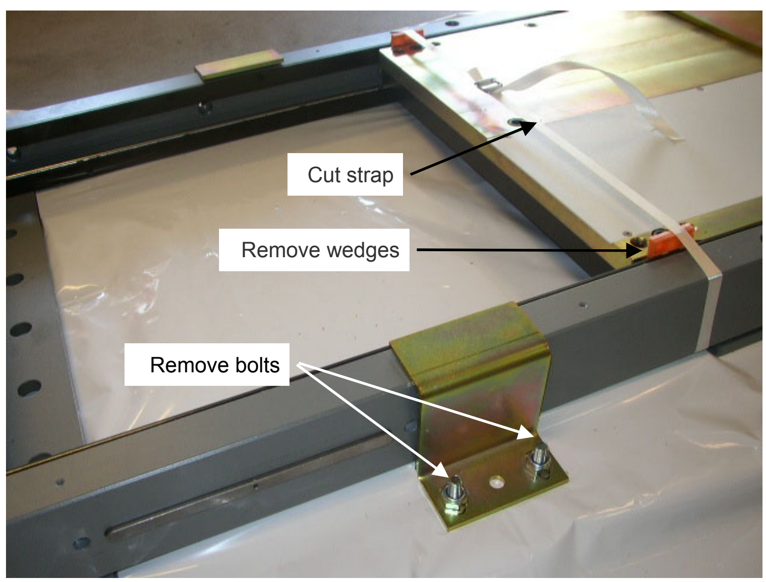
The laptop PC mounting option is shipped in a single box.

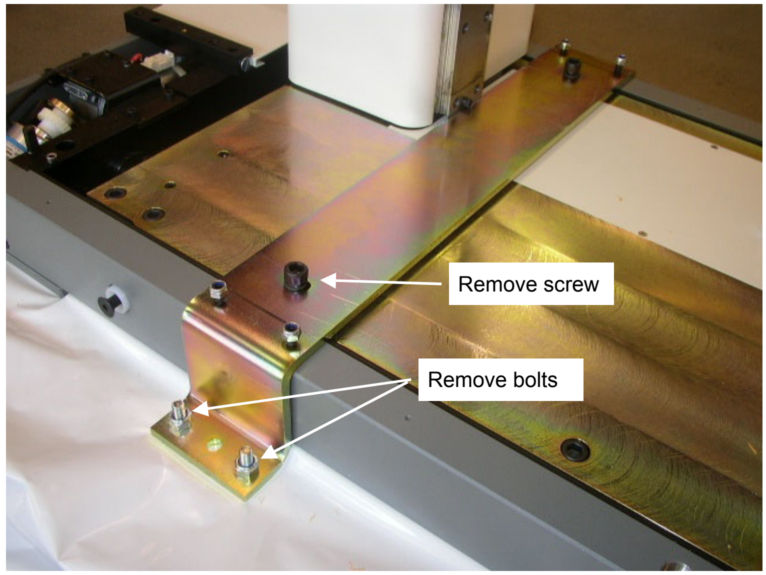
Procedure	***Details***
The cart-mount option is shipped in a plywood box, 31.5 × 47 × 37 inch / 80 × 120 × 93 cm. The wall-mount and desk-mount options are shipped in cardboard boxes, 19.7 × 110.6 × 10.6 inch / 50 × 281 × 27 cm.	 

8. Open the boxes and remove the protection bag by carefully cutting around the edges.

Note. Check the packing list and make sure that all parts are present.

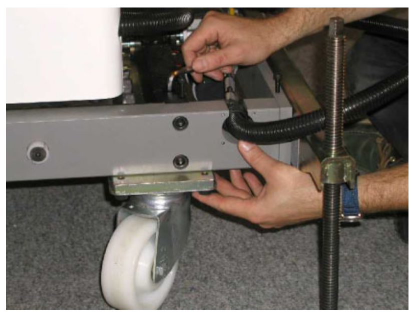
8.3.3.2 Removing End bars and Shipping Brackets

Procedure	***Details***
In order to be able to mount the jack bars, the extensions at both ends of the pallet must be removed. 1. Use a Philips bit to remove all 4 steel angles, and remove the 2 pieces of wood.	 
2. Using a 16 mm wrench, dismount the 2 small 'Z' shipping brackets, and push the bolts down. 3. Cut the nylon strap and remove the 2 wedges.	

Procedure	*Details*
4. To remove the large shipping bracket, remove 2 bolts and 1 screw at each end of the bracket.	

8.3.3.3 Removing Gantry Shipping Pallet using Dolly Beams

Procedure	*Details*
1. Locate the 2 jack beams, the 2 wheel bars, 4 plastic protective feet, 4 screws M12 × 75 mm, and a ½” ratchet.	
2. Using 4 pcs. M12 × 75 mm socket head cap screw and a 10 mm Allen wrench, mount a jack beam in each end of the gantry. The side with protective rubber against the painted surface of the end bar. 3. Apply a plastic protective foot under each acme screw. 4. Using a ½” ratchet, raise the gantry by app. 1 inch (25 mm).	 

Procedure	***Details***
5. In order to protect the 3 cables, make sure they are safely placed on the gantry base. 6. Pull out the pallet.	 
7. Using an 8 mm Allen wrench, loosen the 2 M10 screws in each end bar and remove the mounting plates in each end. 8. Leave the plate in the middle.	 
9. Raise the gantry to app 8” (20 cm) above the floor level and mount a wheel bar in each end by using the same screws in the same holes used for the mounting plates.	 
10. Lower the jack until the gantry is standing on the four wheels. 11. If required, remove the jack beams.	

Note. The Gantry on its Dolly with the jack beams mounted can go through 91 cm (3 ft.) doorways.

Without the jack beams, the gantry can pass a doorway of 75 cm (2.5 ft.).

8.3.3.4 Determining the Actual Position for the System

Note. Use the template shipped with the system to determine the actual position of the gantry.

The template shipped with the system (see Figure 8.17 page 8-30) provides information on the minimum distance to the walls, the minimum room layout for installation with a small table (supine patients only) and a large table (supine and prone patients), as well as the preferred

position of the holes for anchors. If rebars or tensioning cables in the floor obstruct drilling, alternative holes are provided.

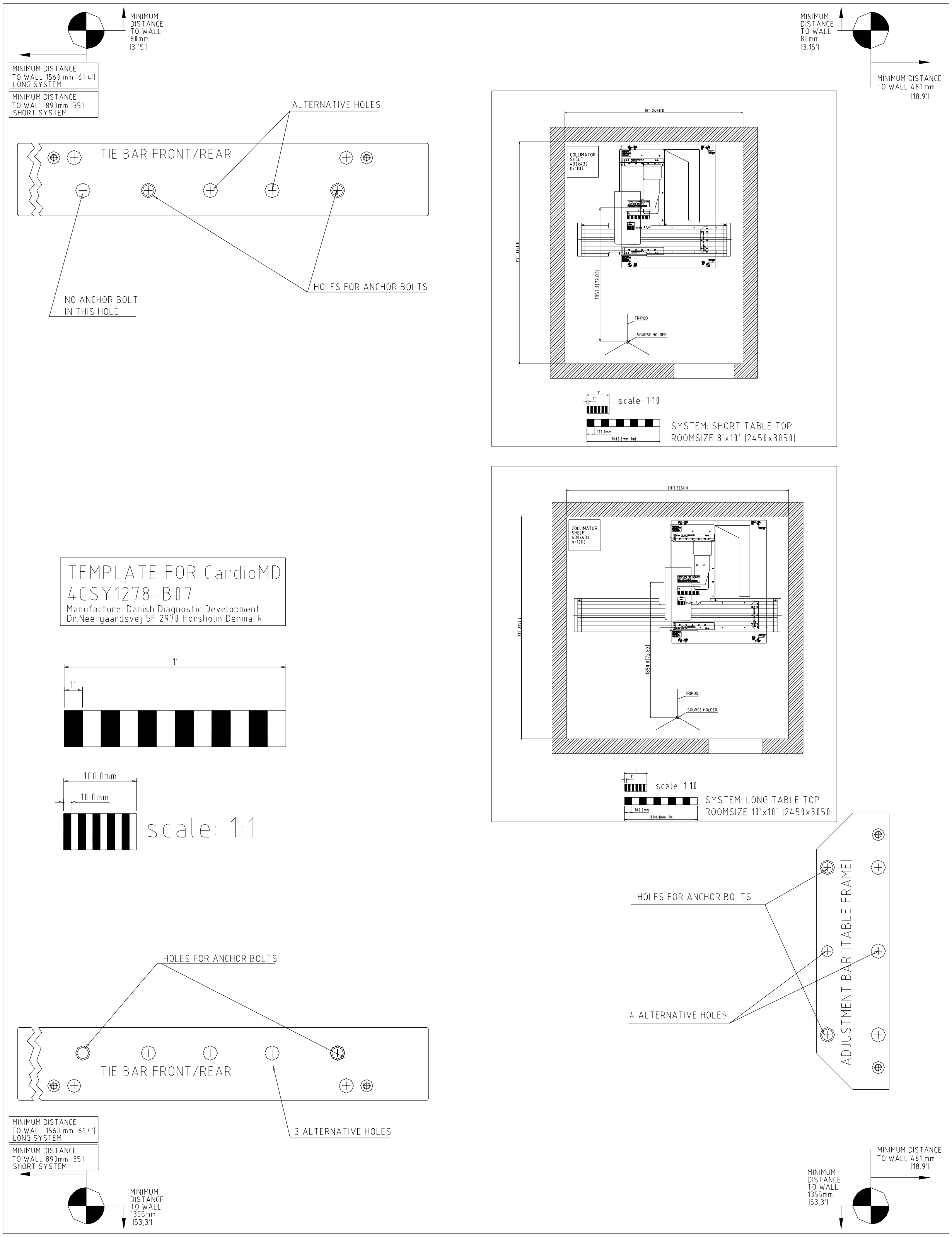
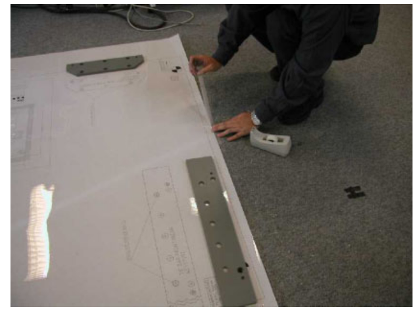
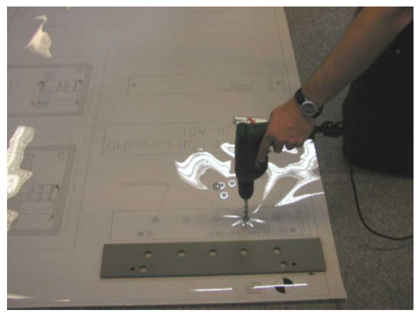


Figure 8.17 Installation template

Procedure	Details
1. Using the template shipped with the system and a plan of the room layout, measure the minimum distance to the walls. 2. Position the template. 3. Use adhesive tape to fix the template to the floor.	 

8.3.3.5 Drilling Holes and Setting Anchors

Procedure	Details
1. Drill 6 holes, 2¼" (55 mm) deep, for anchors through the template. Use the 15 mm masonry drill. You may use a hammer drill for a pilot hole. 2. Remove the template and clean the holes.	

Note. If rebars or tensioning cables in the floor obstruct drilling, use the alternative holes provided.

Procedure	Details
3. Use a mandrel to set the anchors.	

8.3.3.6 Transporting the Gantry to the Installation Room

Note. If the corridor has a 90° corner, the corridor width must be at least 42” (105 cm). See Figure 8.18. The gantry on its dolly with the jack beams mounted can go through 91 cm (36”) doorways. Without the jack beams, the gantry can pass a doorway of 75 cm (30”).

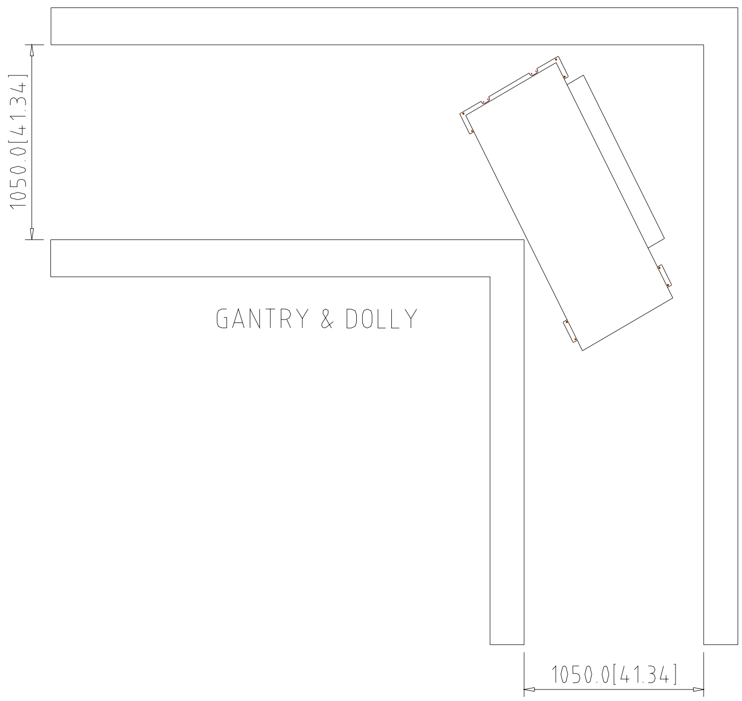
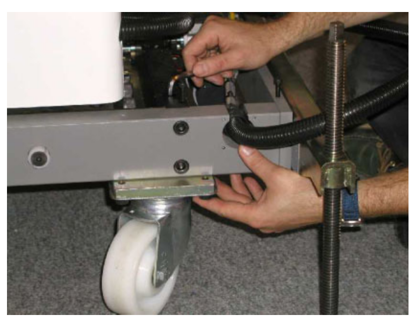
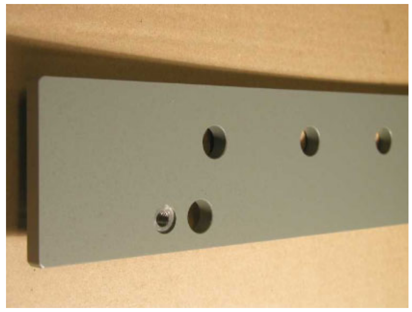


Figure 8.18 Passage clearance for gantry

Procedure	*Details*
1. Roll the gantry in position over the anchors holes. 2. If the jack beams have been removed, remount these now. 3. Jack up and dismount the dolly wheels.	 

8.3.3.7 Anchoring the Mounting Plates

Procedure	*Details*
1. Place the 2 mounting plates over the holes. Make sure that the side with countersunk around the M10 hole is facing upwards. 2. Mount 4 of the 6 M12 × 30 anchor screws and washers shipped with the system. 3. Do *not* tighten the anchors yet.	 

Note. Seismic installations require use of the optional CardioMD Seismic Kit. Instructions for seismic installation are included with the kit.

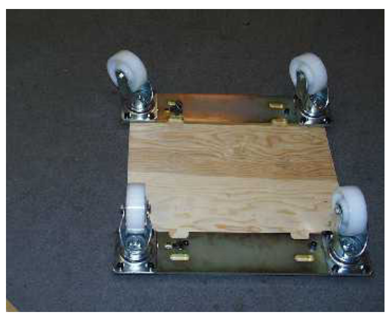
8.3.3.8 Positioning the Gantry

Procedure	*Details*
1. Lower the jacks until the gantry is about 3/4" (20 mm) above the mounting plates. If needed, push the gantry until the 4 screw heads below the gantry end bars align with the 2 holes in each mounting plate. The screw heads will guide the gantry while the jacks are being lowered the last 12 mm to the floor. 2. When the jacks are free, check that the four M10 mounting screws can be installed. 3. Dismount the jack beams.	

8.3.3.9 Inserting the Neoprene Weather Strip

Procedure	***Details***
1. Insert the 15 × 20 mm neoprene weather strip shipped with the system between the outside edge of the gantry frame and the floor. This will prevent dirt from entering underneath the gantry. 2. Cut the strip to fit between the mounting plates.	

8.3.3.10 Rebuilding the Trolley for Transporting the Table Base

Procedure	***Details***
Use the two wheel bars and the rectangular plywood plate to build a trolley: 1. Mount the wheel bars to the plate using 4 pcs. M10 × 30 mm screws (shipped with the plate). Use an 8 mm Allen wrench to tighten the screws.	 
2. Cut the strap, and remove the 2 side covers from the table base. 3. Store the covers for later use.	

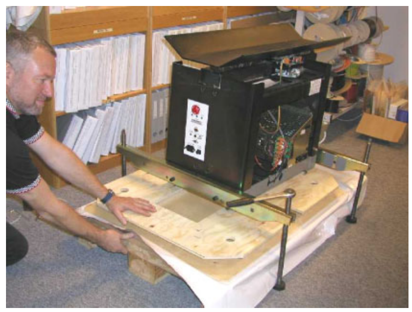
8.3.3.11 Removing the Table Base Pallet

Procedure	***Details***

1. Mount the 2 jack beams to the table base using 2 pcs. M10 × 70 mm and an 8 mm Allan wrench.

The screws are mounted in the table base when shipped.


2. Using a ½” ratchet, raise the jacks by approximately 1” (25 mm), and remove the pallet.
3. Position the trolley below the table base, and lower the table base onto the trolley.
4. Remove the jack beams if needed for passing narrow doors.




8.3.3.12 Positioning the Table Base

Procedure	***Details***

1. Move the table base on the trolley and position it close to its final position. Leave approximately 4” (10 cm) space between gantry and table base, in order to be able to remount/dismount the jack bars.
2. If the jack bars have been removed, re-mount these now.
3. Raise the jacks and remove the trolley.


8.3.3.13 Mounting the Guide Screws

Procedure	***Details***

1. Lower the table base and remove the front jack beam, leaving the rear jack beam approximately 1” (25 mm) above the floor.
2. Place the 2 protective plastic feet under the front end of the table base.
3. Insert the 2 long M10 bolts (shipped with the system) through the gantry frame into the threaded holes in the table base. Use a


Procedure	***Details***
17 mm wrench.	

8.3.3.14 Mounting the Table Console to the Gantry Frame

Procedure	***Details***

1. Using the long bolts as guides, push the table base in position. A key in the gantry frame will guide the base the last ¼” (5 mm).
2. Remove the long screws and replace them with M10 × 20 mounting screws, one at the time.

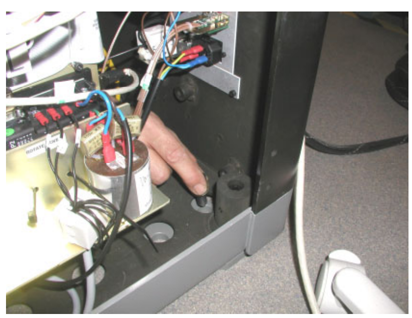

3. Using an 8 mm Allen wrench, tighten the screws and loosen each screw again by approximately half a turn of the wrench.

4. Lower the rear end of the table base and remove the jack beam.

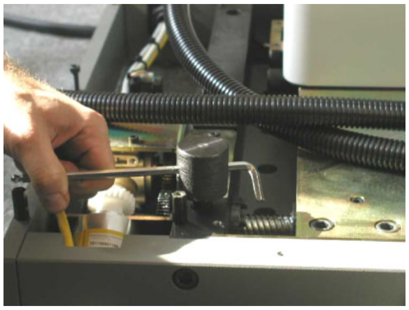
8.3.3.15 Mounting Anchors for Table Console

Procedure	***Details***

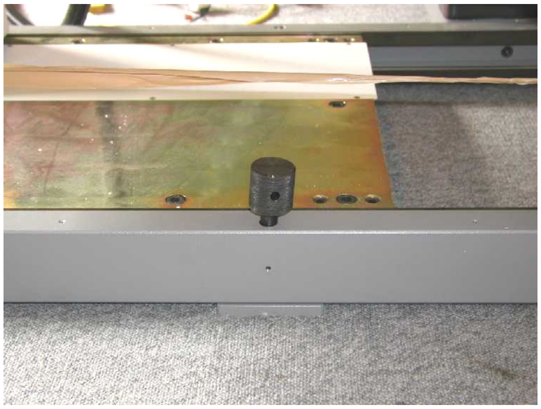
1. Using a 10 mm Allen key, mount 2 M12 × 30 anchor screws with washers at the rear end of the table. Tighten the bolts.
2. Also tighten the 2 anchor bolts at the front end of the gantry.




8.3.3.16 Leveling the Gantry Base

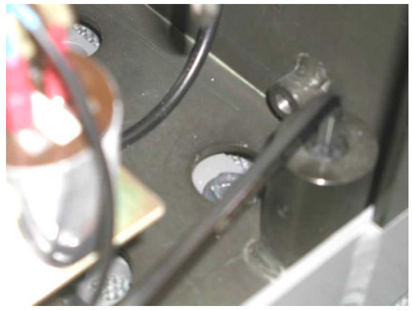
Procedure	*Details*
1. Using an 8 mm Allen wrench, remove the 4 mounting screws in the gantry frame in order to get access to the leveling screws. 2. Using a level and the adjusting tool, level the side bar opposite the table base.	 
3. Level both end bars, and check the side bar, where the table base is mounted. 4. Reinsert the 4 mounting screws and tighten them.	 

8.3.3.17 Adjusting Center Leveling Screws

Procedure	*Details*
1. Remove the mounting screw in the middle of one of the sidebars and adjust the leveling screw until the plate is just supported on floor. 2. Remount the mounting screw. 3. Perform the same adjustment on the other sidebar.	

Note. Check this once again. It is very important that the 2 sidebars are in level and parallel (+/– 0.05°).

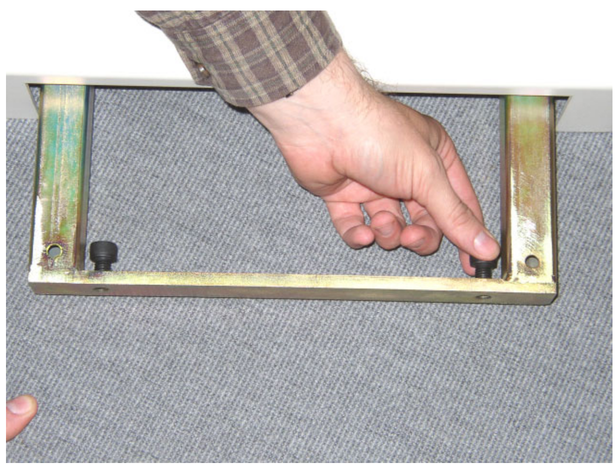
8.3.3.18 Leveling the Table Base

Procedure	*Details*
1. Remove the mounting screws in the rear end of the table base. 2. Using a level and the adjusting tool, level the table base. 3. Remount the mounting screws.	 

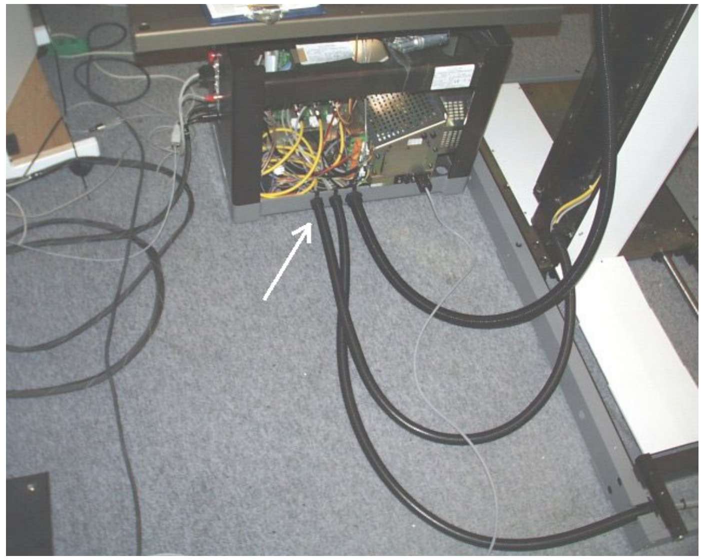
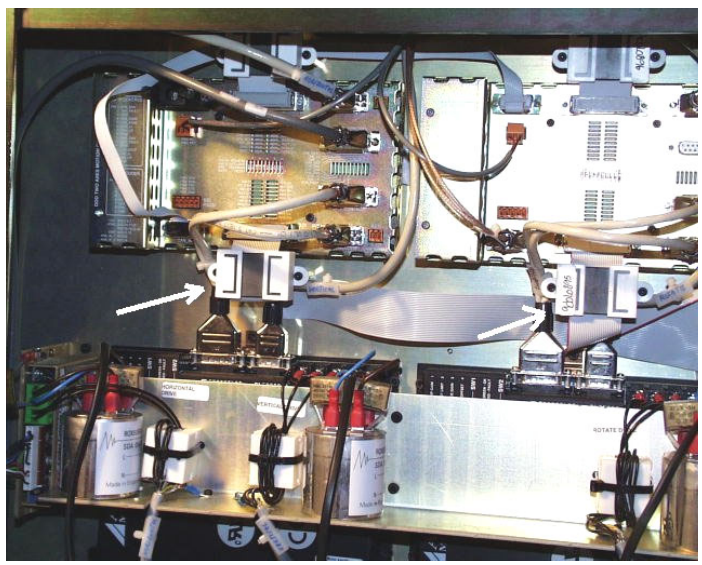
8.3.3.19 Removing the 2 Shipping Locks

Procedure	*Details*
1. Tighten the mounting screws connecting the table base and gantry frame. 2. Using an 6 mm Allen wrench, remove the 2 shipping locks located in the gantry sidebars.	 

8.3.3.20 Mounting the Patient Table Support

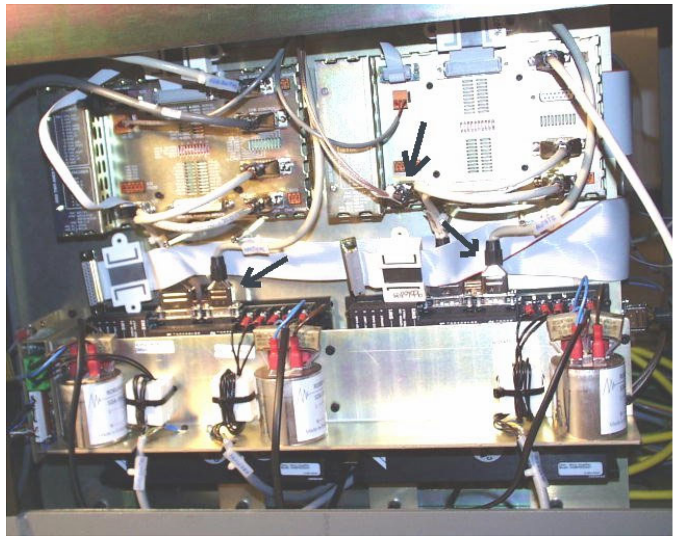
Procedure	*Details*
1. Mount the table end support onto the gantry base using two M8 bolts.	

8.3.3.21 Electrical Connections between Detector, X-drive, Y-drive and Table Console

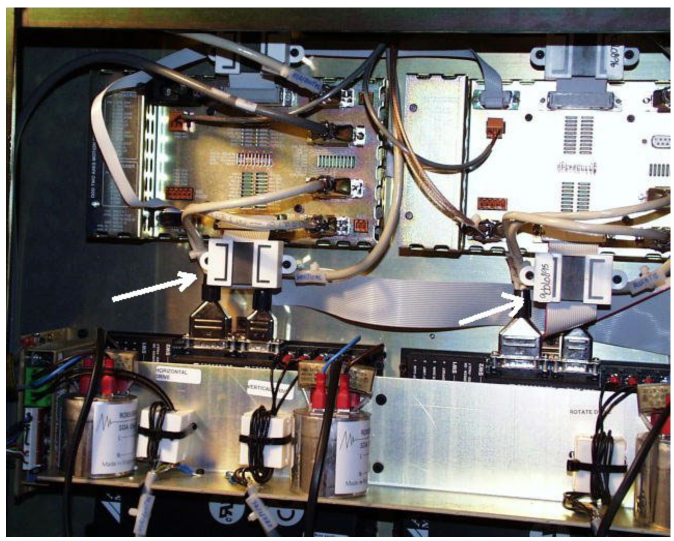
Procedure	*Details*
1. For all three cable conduits, unscrew the nuts and place the cables in the three slotted holes at the bottom of the table console. The thick conduit from the detector rotate gear goes into the right-hand hole. The conduit from the gantry base goes into the middle hole. The conduit from the bottom of the Y-pillar goes into the left hole. 2. Tighten the nuts by hand.	
3. From the front side of the table console, remove the fixing screws of the two rectangular ferrite filters in the front compartment of the table console.	

Procedure	***Details***

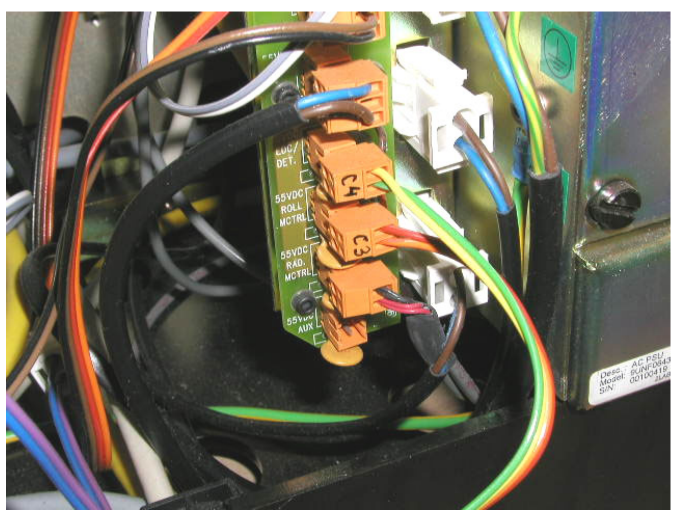
4. Pull the CANbus cable (coming out of the thick conduit with a DB9 connector) through one of the openings at the *upper* edge of the separating wall in the console.
5. Plug the DB9 into the connector labeled BZ3 on the motion controller to the right.
6. Plug the DB15-HD into the mating connector on the rotate motor amplifier (the black unit to the right).
7. Tighten the retaining screws.
8. Plug the DB15-HD into the mating connector on the vertical motor amplifier (the black unit in the middle).
9. Tighten the retaining screws.

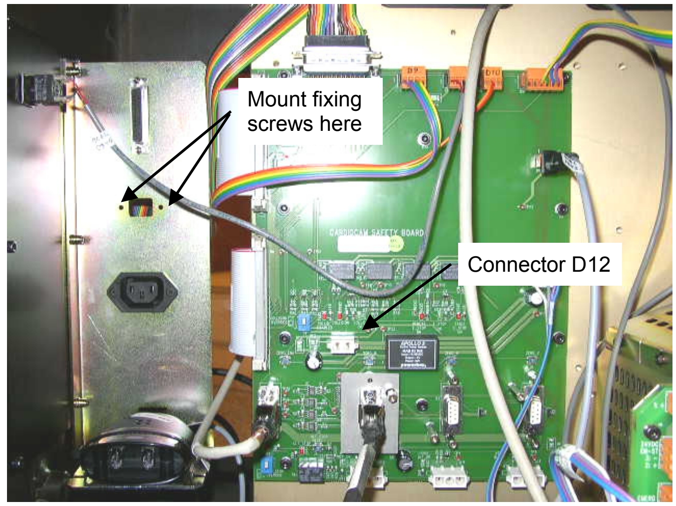
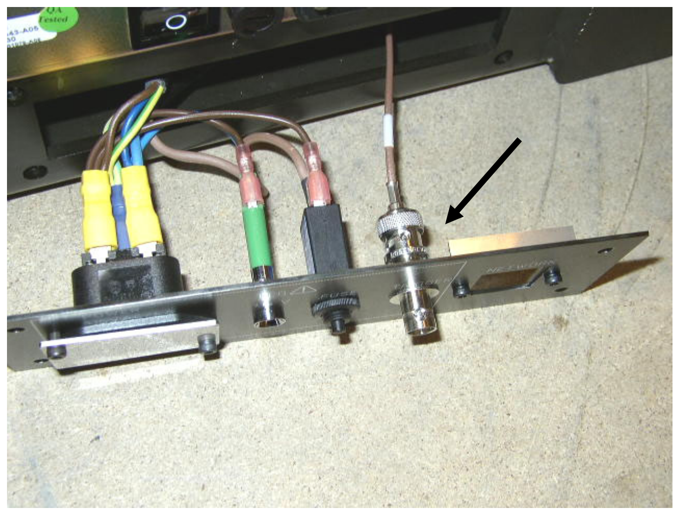
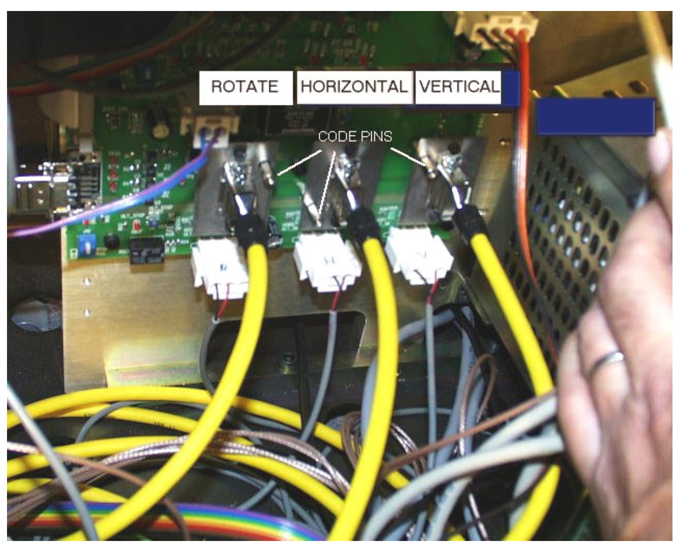


10. Attach the rectangular ferrite filters to the standoffs where they came off, using the fixing screws.



11. Go to the back of the table console.
12. Plug the two connectors labeled C3 and C4 into two similarly labeled connectors on the power supply panel.
13. Attach the eye terminal of the yellow/green wire to the ground screw on the power supply frame.



Procedure	*Details*
14. Take the two fixing screws out of the FireWire connector and hold it against the internal connector panel from the rear of the system. 15. Mount the fixing screws from the front side of the system. 16. From the front side, insert the FireWire cable from the FireWire hub into the mounted FireWire connector. 17. Plug the 2-way M-N-L connector marked D12 into connector D12 on the safety board.	
18. Attach the BNC connector to the BNC adapter (for the ECG gate) on the rear connector panel. **Note**. You may have to remove the connector panel to access the BNC adapter.	
Three yellow cables are equipped with DB9 connectors with code plates mounted. Each code plate will only fit in one position over the three DB9 connectors on the safety board. 19. Connect the three cables at the correct positions and fasten the socket-headed retaining screws. 20. Plug the three cables with 3-way M-N-L connector into the mating connectors on the safety board. "R" goes to D15, "H" goes to D14 and "V" goes to D13.	

8.3.3.22 Assembling the Laptop PC Mounting Option

Three different mounting options are provided for the laptop acquisition PC. These are:

- A cart-mount option
- A wall-mount option
- A desk-mount option.

The following sections describe the installation of each of the three options, including the connection of the laptop PC to the gantry.

Note. The laptop installation kit includes 3 m (10 ft.) of rubber cable protector for routing of cables through traffic areas. Before starting the installation, remove the cable protector from the packaging and place it flat on the floor out of the way, allowing 'curl' to relax.

Cart-mount Option

Installing the cart comprises the following steps:

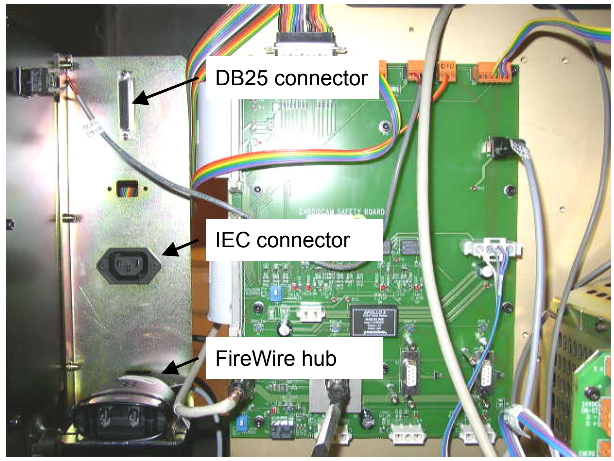
1. Unpacking the cart
2. Connecting the cable from the cart to the gantry
3. Mounting the laptop power supply in the cart stand
4. Connecting the laptop PC.

After the cart is unpacked, follow these steps to connect the cable to the gantry:

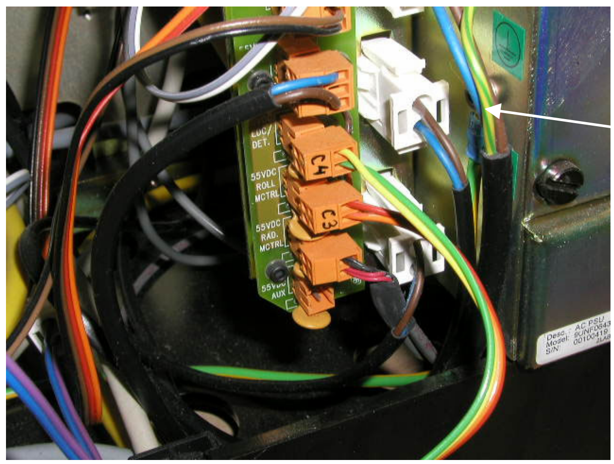
Procedure	*Details*
1. Push the cable from the cart through the entry hole in the gantry. 2. Fasten the plate to the gantry using the M4 x 8 screws.	

Procedure ***Details***

3. Connect the hand-controller/LED/E-stop cable to the DB25 connector on the internal connector panel.
4. Connect the power cable to the IEC connector.
5. Connect the FireWire cable to any of the ports on the FireWire hub.

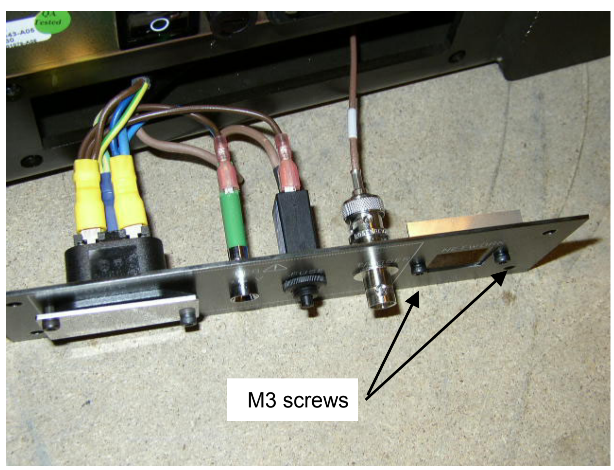


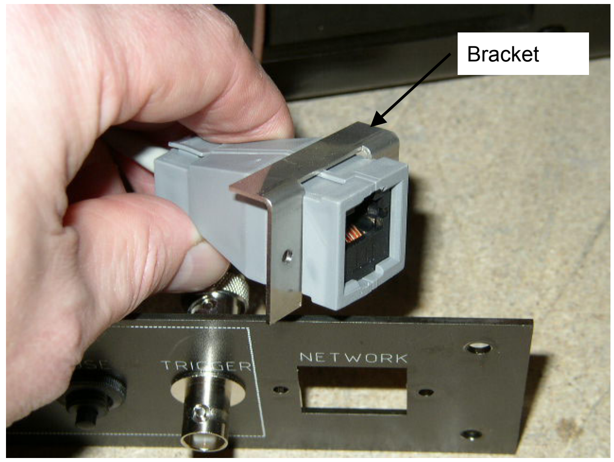
6. Attach the eye terminal of the yellow/green ground wire to the ground screw on the power supply frame.



Gound wire

7. Remove the rear connector panel for the ECG gate by unscrewing the four M4 x 8 screws holding the panel.
8. Unscrew the two M3 screws to remove the small bracket for the Ethernet connector



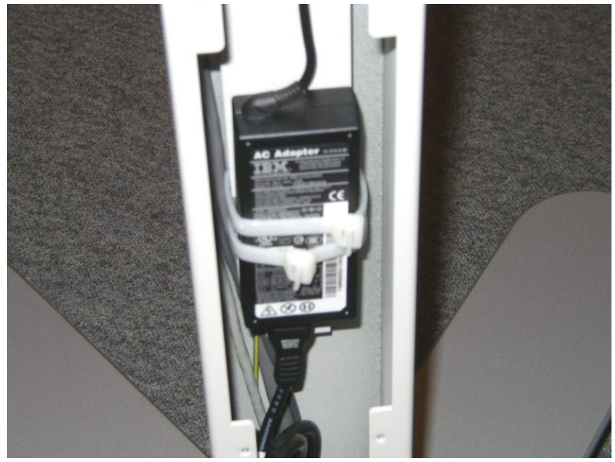
Procedure	***Details***
9. Place the bracket on the Ethernet connector and mount the connector to the rear panel. 10. Mount the panel again on the rear of the table console.	

Note. Strain relief should be added to the gantry-PC interface cable as follows:

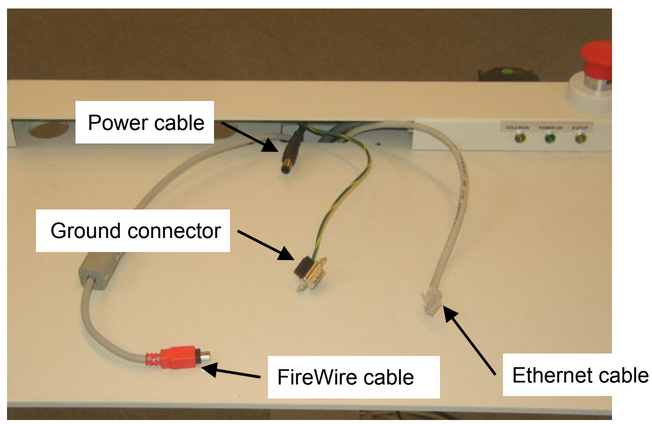
Procedure	***Details***
11. After making all connections, take all excess cable length to the interior of the gantry. 12. To prevent cable connections from being stressed, attach two large Ty-Wraps to the cable on the inside of the cabinet.	

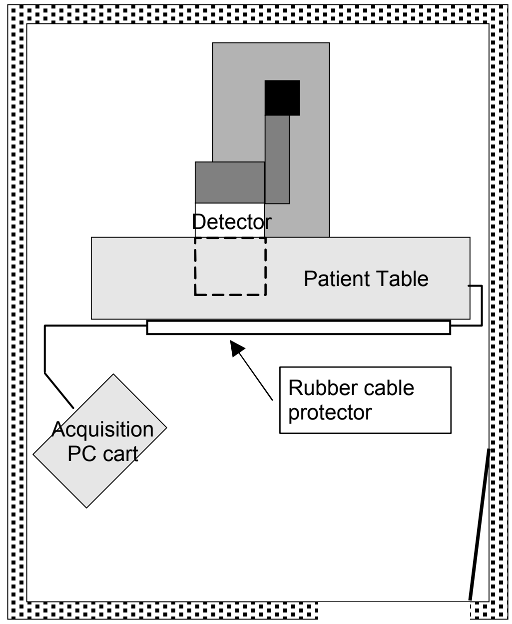
To mount the laptop power supply in the PC cart stand, proceed as follows:

Procedure	***Details***
1. Remove the cover on the rear side of the stand.	

Procedure	*Details*
2. Use a couple of Ty-Wraps to fix the laptop power supply to the bracket inside the cart stand. 3. Route the power connector for the laptop PC up and through the hole in the top plate. 4. Connect the power supply mains connector to the IEC power connector on the gantry cable. 5. Mount the cover on the rear of the cart stand.	

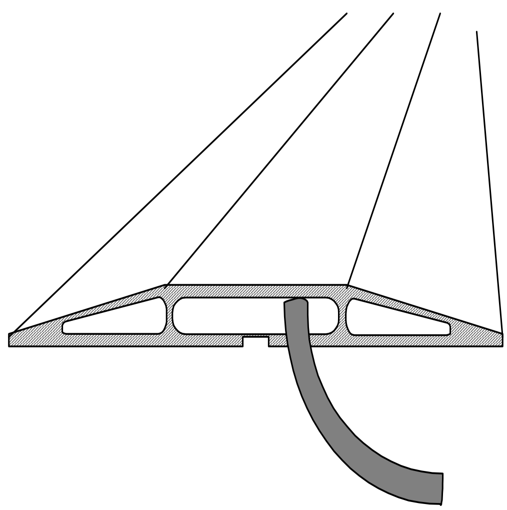
To connect the laptop PC and hand controller, proceed as follows:

Procedure	*Details*
1. Connect the FireWire cable to the FireWire connector on the laptop PC. 2. Connect the power cable to laptop PC's power input. 3. Connect the DB9 connector to the laptop PC's monitor output. This connection is only required to ground the laptop PC for EMI/EMC reasons. 4. Connect the Ethernet cable to the laptop PC's network connector.	
5. Connect the external mouse to a USB port on the laptop PC. 6. Connect the hand controller to the DB25 connector on the rear side of the cart top plate, next to the E-Stop button.	

Procedure	*Details*
The gantry-PC interface cable must be protected by means of approximately 1.5 m of rubber cable protector, routed and secured to the floor as indicated to the right.	

WARNING

Trip hazard! Failing to protect and secure the gantry-PC interface cable may cause cables to be damaged and persons to trip over the cable.

Procedure	*Details*
The CardioMD system is supplied with 3 m (10 ft.) of rubber cable protectors, used for covering cables running from the gantry to the wall (power and network cables) and the cable between gantry and acquisition PC. Cable protectors should be applied where traffic across the cables is to be expected. 7. Cut cable protectors to desired lengths. 8. Open the membrane on the base of the protector to slide in the cable.	

Wall-mount Option

Installing the wall-mounted acquisition PC involves the following steps:

1. Unpacking the wall-mount kit
2. Mounting the base on the wall
3. Assembling the wall-mount kit
4. Routing cable to the gantry and applying wiremolds
5. Connecting the cable from the wall mount to the gantry.

After unpacking the wall-mount kit, proceed as follows to determine the position for the wall-mounted laptop and to mount the base of the wall mount kit to the wall:

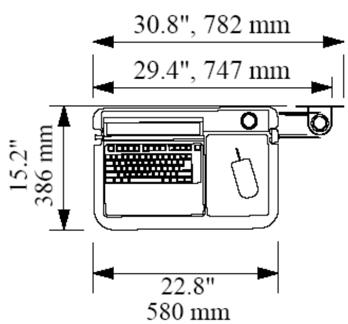
Procedure	*Details*

1. Determine where the wall-mounted laptop acquisition PC should be located.

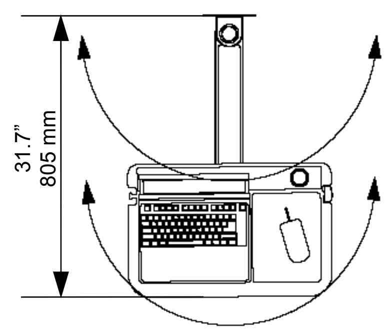
If in doubt of where to place the laptop PC in order to ensure a convenient workflow, discuss its position with the customer.

In determining the position, consider that the arm extends when the platform is rotated over the 180° arc. This is of particular importance when installing in small rooms where the laptop may block entrances or passageways when swung.

In small rooms, it is recommended always to have the laptop arm folded against the wall.



Arm folded against wall



Arm extended

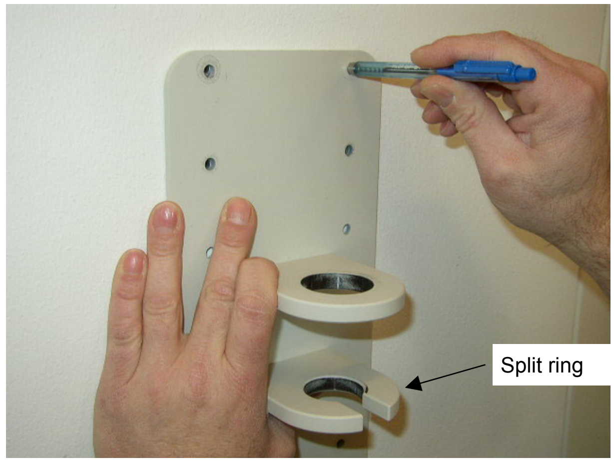
2. Check that the cable from the wall-mounting kit to the gantry is sufficiently long to be routed nicely in the wiremolds supplied as part of the wall-mount option.

If the cable is too short, you must find an alternative position for the wall-mounted acquisition PC closer to the gantry.

CAUTION

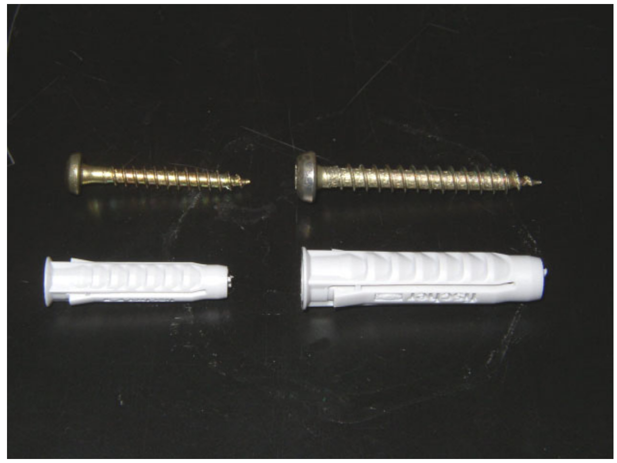
Caution. When installing the wall-mount option for the CardioMD acquisition PC, at least one vertical edge of the wall mounting plate must be secured to stud. Installing the wall mounting plate only to drywall may cause drywall fracture.

Note. It is recommended that the laptop is mounted on the wall at a height of approximately 40” above the floor, which is suitable for most people. However, discuss the mounting height with the customer to determine the best compromise.

Procedure	***Details***
After determining the position of the wall-mount: 3. Hold the mounting plate towards the wall and mark the upper right *or* left mounting hole.	

Note. The wall mounting plate must be installed with the split ring closest to floor.

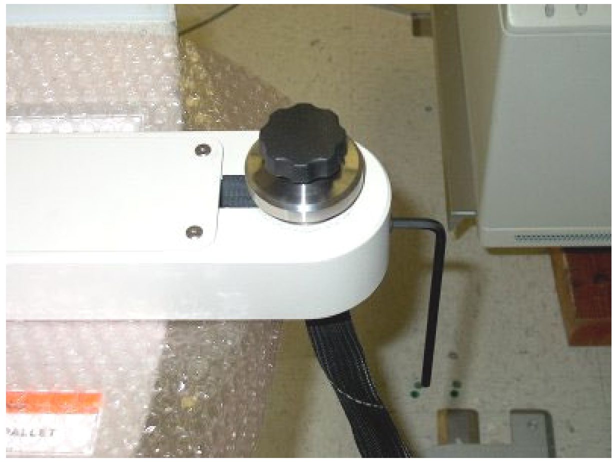
Procedure	***Details***
If the screw will be placed in a stud: 4. Use a 2 mm drill to drill the hole. 5. Mount the plate with this first screw.	
If working in drywall, you must use the dedicated screws and anchors supplied with the kit (see photo on the right): 4. Drill a pilot hole and then use a 10 mm drill for the final hole. 5. Remove the screw from the anchor and insert the anchor in the hole just drilled in the wall. Seat the anchor firmly into the drywall by tapping with a hammer. 6. Fasten the mounting plate with the first screw.	

Procedure	*Details*
If working in a solid wall, use the plugs supplied for this purpose (the larger plug and screw shown in the photo on the right): 4. Use an 8 mm drill to drill holes for the wall plugs supplied with the kit. 5. Insert a plug into the hole just drilled. Seat plug firmly into the wall by tapping with a hammer. 6. Fasten the mounting plate with the first screw.	
7. Level the wall mount plate and mark the remaining 3 upper holes, as well as the 4 lower mounting holes.	

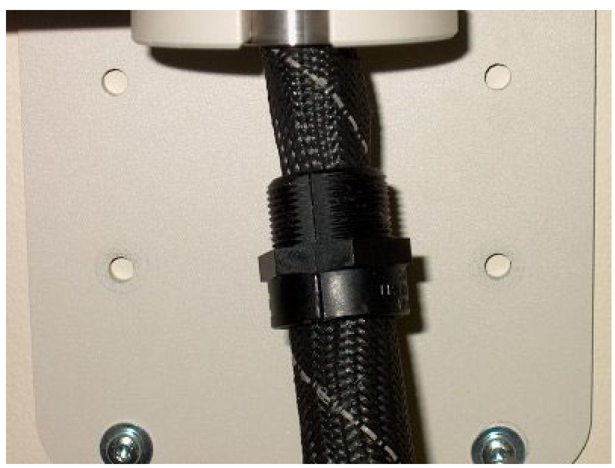
Note. It is critical that the wall mounting plate is level.

Procedure	*Details*
8. Remove the wall mounting plate to give access to drilling the 7 remaining holes. 9. Mount anchors/plugs. Seat anchors/plugs firmly into the wall by tapping with a hammer. 10. Mount the plate and tighten all 8 mounting screws.	

Now proceed as follows to assemble the wall-mount kit:

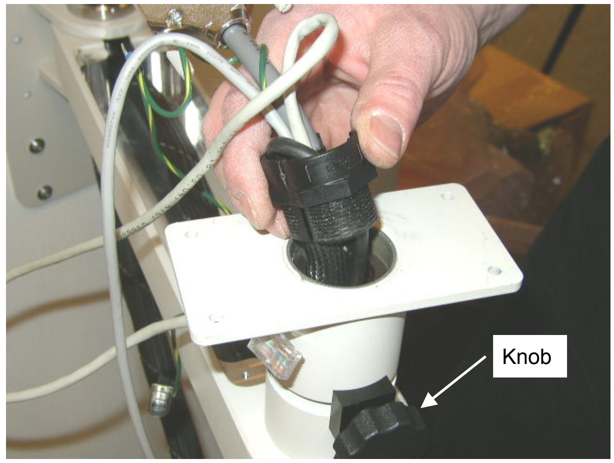
Procedure	***Details***
1. Remove the M6 × 20 cap screw from the rear of the arm.	
2. Remove the cable grommet from the base of the pivot shaft.	
3. Remove the pivot shaft from the arm.	

Procedure	*Details*
4. Locate 4 large steel washers in the installation kit. 5. Place two washers on the pivot shaft.	 
6. Assure that the cable is routed through the arm and escapes through the bottom of the arm. 7. Route the cable through the split ring of the wall mounting plate, assuring that the cable grommet is below the split ring.	
8. Place the arm between the two rings on the wall mounting plate. 9. Place the remaining two large steel washers on top of the arm, under the top ring of the wall mounting plate.	

Procedure	*Details*
10. Move the arm and washers into alignment with the wall mounting plate rings. 11. Insert the pivot shaft so that the slot in the pivot shaft allows the cable to escape the arm/shaft/mounting assembly.	
12. Replace the M6 × 20 cap screw at the rear of the arm. 13. Remove the top cover from the arm.	
14. Replace the cable grommet at the bottom of the pivot shaft.	

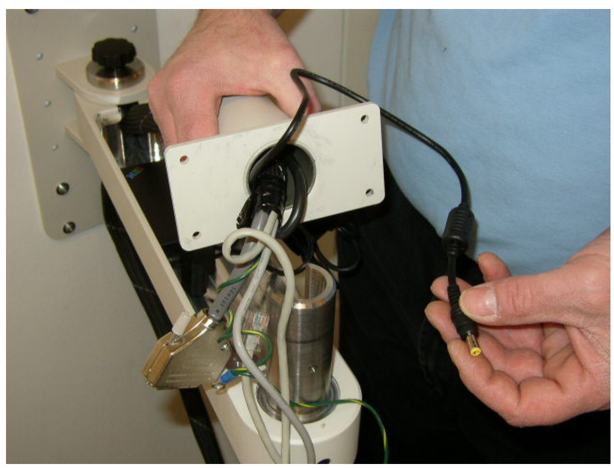
15. At the outer end of the arm, pull up the cable clamp.
16. Remove the knob indicated in the photo on the right.

When in place, this knob serves to lock rotation of the top plate.



17. Locate the laptop PC power supply.
18. Lift up the top bracket from the wall-mount arm.

19. Thread the laptop power cable through the bracket next to the other cables.



20. Connect the power input connector of the laptop power supply to the IEC connector inside the arm.
21. Place the power supply inside the arm.

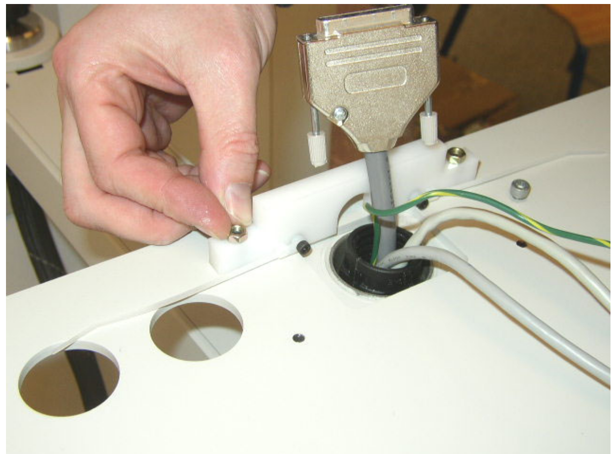
22. Mount the arm cover.

23. On the top plate, remove the 4 screws and the cable bracket.

24. Mount the top plate using the two long screws at the rear and the two shorter ones for the front two holes.

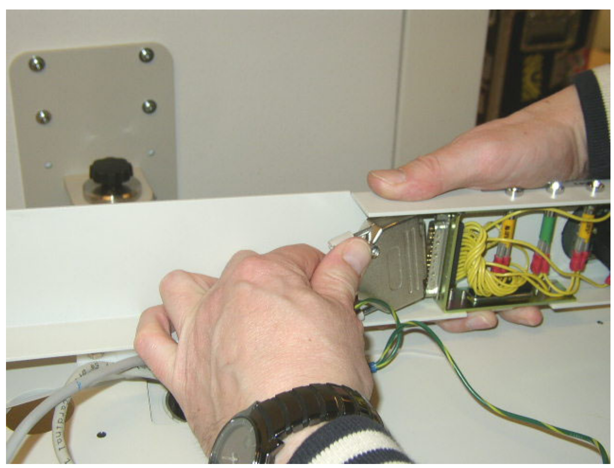
Note. Make sure to mount the top plate with the round air circulation holes to the left.

25. Mount he cable bracket once again using the two M6 nuts.
26. Use a Ty-Wrap to secure the cables to the cable bracket.

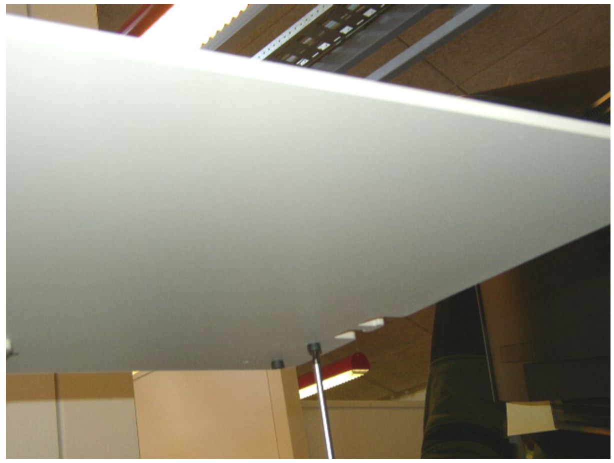


27. Fasten the ground wire to the top plate.

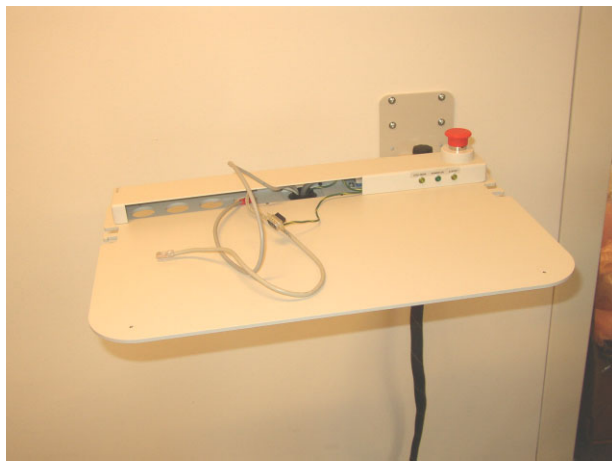
28. Connect the DB25 connector to the box with the three LED's.



29. Mount the LED box using four M6 screws from underneath the top plate.



The photo on the right shows the assembled and mounted wall-mount PC stand.



The next step consists in mounting wiremolds and routing cables. Proceed as follows:

Procedure	***Details***
1. Route wiremolds nicely from the wall-mount to the gantry. Use the adhesive on the wiremolds to attach them to the wall. The wiremolds provided with the system include angles and turns needed for most installations. In case you need additional parts, these can be obtained locally.	

Note. The adhesive on the wiremolds is only intended as an aid when installing. The adhesive is not sufficiently strong to keep wiremolds in place for longer periods of time.

Procedure	***Details***

2. With a 6 mm drill, drill holes through the wiremold and into the wall.

Note. Take care to avoid any studs.

3. Insert wall plugs into the holes drilled.
4. Use the screws provided with the system to secure wiremolds.

5. Route the cable to the gantry inside the mounted wiremold.

WARNING

Never route the gantry-PC interface cable together with any other cables. Due to safety and EMC/EMI considerations, the cable connecting the acquisition PC to the gantry *must* be routed in separate wiremolds.

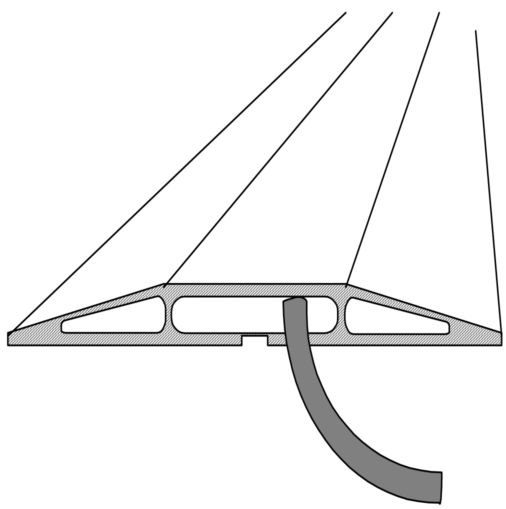
Procedure	***Details***

6. Use a part of the rubber protector supplied with the system to protect the cable from the wall to the gantry.

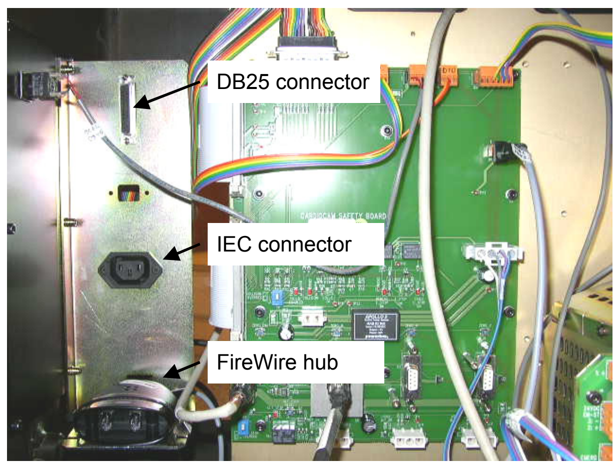
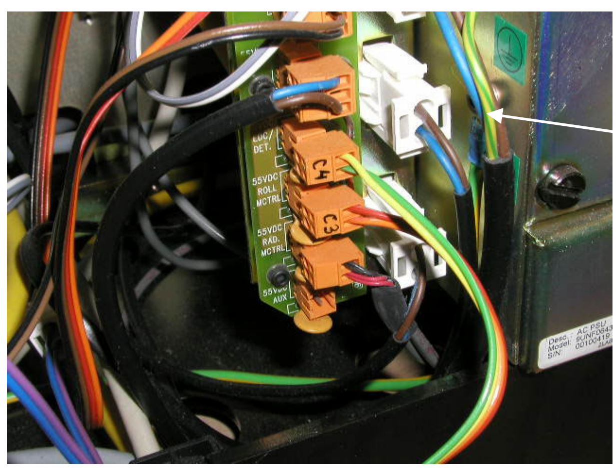
3 m (10 ft) of rubber cable protectors are provided to cover cables running from the gantry to the wall (power and network cables) and the cable between gantry and PC. The cable protectors should be applied where traffic across cables must be expected.

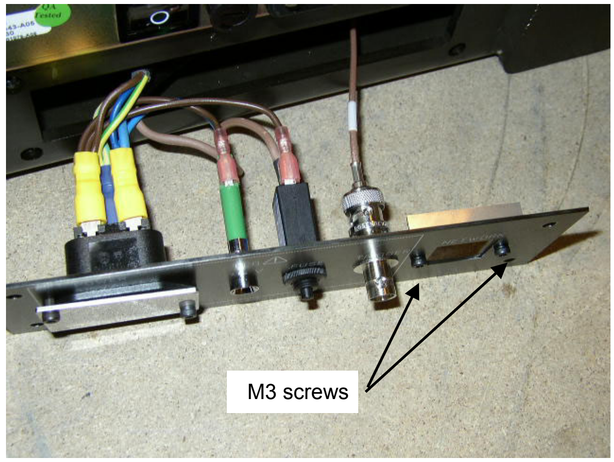
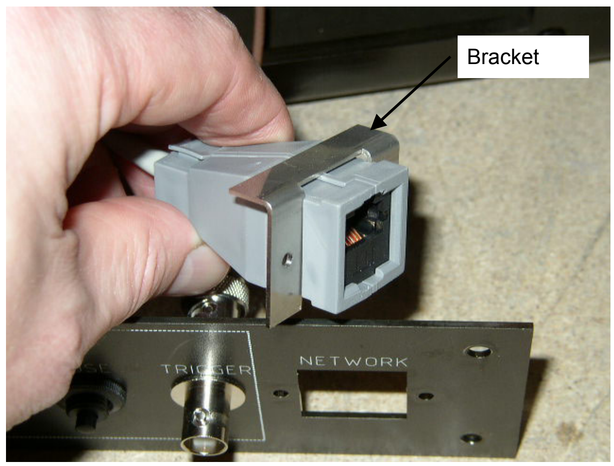
7. Cut cable protectors to desired lengths.

   Open the membrane at the base of the protector to slide in the cable.



Connect the PC-gantry cable to the gantry as follows:

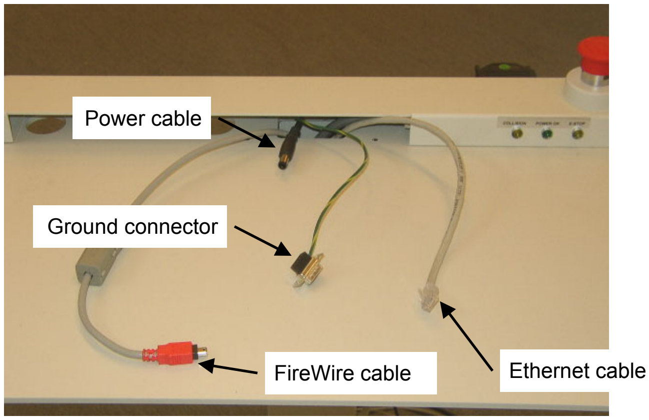
Procedure	***Details***
1. Push the cable coming from the acquisition PC wall-mount through the entry hole in the gantry. 2. Fasten the plate to the gantry using the M4 x 8 screws.	
3. Connect the hand-controller/LED/E-stop cable to the DB25 connector on the internal connector panel. 4. Connect the power cable to the IEC connector. 5. Connect the FireWire cable to any of the ports on the FireWire hub.	
6. Attach the eye terminal of the yellow/green ground wire to the ground screw on the power supply frame.	

Procedure	*Details*
7. Remove the rear connector panel for the ECG gate by unscrewing the four M4 x 8 screws holding the panel. 8. Unscrew the two M3 screws to remove the small bracket for the Ethernet connector	
9. Place the bracket on the Ethernet connector and mount the connector to the rear panel. 10. Mount the panel again on the rear of the table console.	

Note. Strain relief should be added to the gantry-PC interface cable as follows:

Procedure	*Details*
11. After making all connections, take all excess cable length to the interior of the gantry. 12. To prevent cable connections from being stressed, attach two large Ty-Wraps to the cable on the inside of the cabinet.	

To connect the laptop PC and hand controller, proceed as follows:

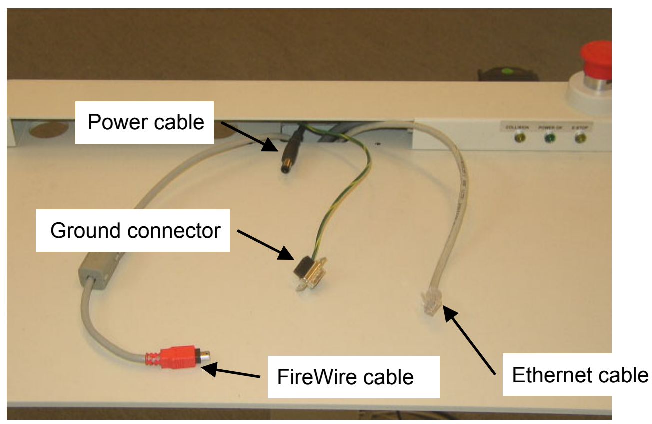
Procedure	***Details***
1. Connect the FireWire cable to the FireWire connector on the laptop PC. 2. Connect the power cable to laptop PC's power input. 3. Connect the DB9 connector to the laptop PC's monitor output. This connection is only required to ground the laptop PC for EMI/EMC reasons. 4. Connect the Ethernet cable to the laptop PC's network connector. 5. Connect the external mouse to a USB port on the laptop PC. 6. Connect the hand controller to the DB25 connector on the rear side of the wall-mount top plate, next to the E-Stop button.	 

Desk-mount Option

Installing the desk-mount acquisition PC option comprises the following steps:

1. Unpacking the desk-mount kit.
2. Positioning and connecting the desk-mounted laptop PC.
3. Routing cable to gantry and applying wiremolds
4. Connecting the cable from the desk mount to the gantry.

After unpacking the desk-mount kit, proceed as follows to connect the laptop PC:

Procedure	***Details***
1. Locate the laptop PC power supply.	
2. Connect the power supply to the IEC power connector.	
The PC power cable can be threaded through the hole on the rear side of the desk-mount, allowing the power supply to be positioned behind the desk-mount.	
3. Route the PC power cable to the front of the desk-mount and connect it to the laptop PC's power input. 4. Connect the FireWire cable to the FireWire connector on the laptop PC. 5. Connect the DB9 connector to the laptop PC's monitor output. This connection is only required to ground the laptop PC for EMI/EMC reasons. 6. Connect the Ethernet cable to the laptop PC's network connector.	
7. Connect the external mouse to a USB port on the laptop PC.	
8. Connect the hand controller to the DB25 connector on the rear side of the desk-mount top plate, next to the E-Stop button.	

Next, mount wiremolds and route the cable to the gantry. Proceed as follows:

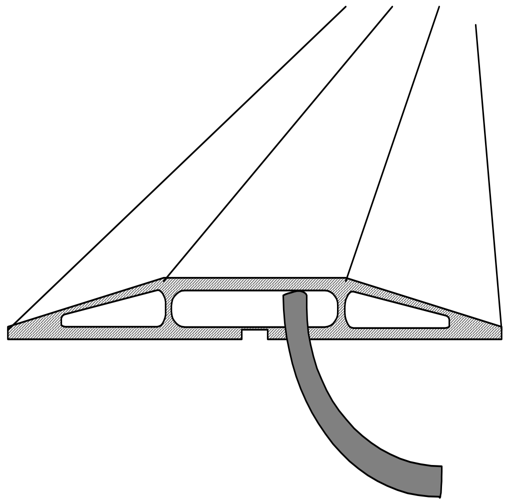
Procedure	***Details***
1. Route wiremolds nicely from the desk-mounted laptop to the gantry. Use the adhesive on the wiremolds to attach them to the wall. The wiremolds provided with the system include angles and turns needed for most installations. In case you need additional parts, these can be obtained locally.	

Note. The adhesive on the wiremolds is only intended as an aid when installing. The adhesive is not sufficiently strong to keep wiremolds in place for longer periods of time.

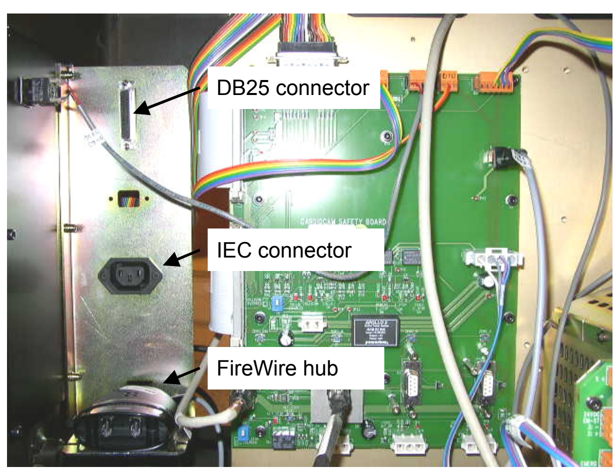
Procedure	***Details***
2. With a 6 mm drill, drill holes through the wiremold and into the wall. **Note**. Take care to avoid any studs. 3. Insert wall plugs into the holes drilled. 4. Use the screws provided with the system to secure wiremolds.	
5. Route the cable to the gantry inside the mounted wiremold.	

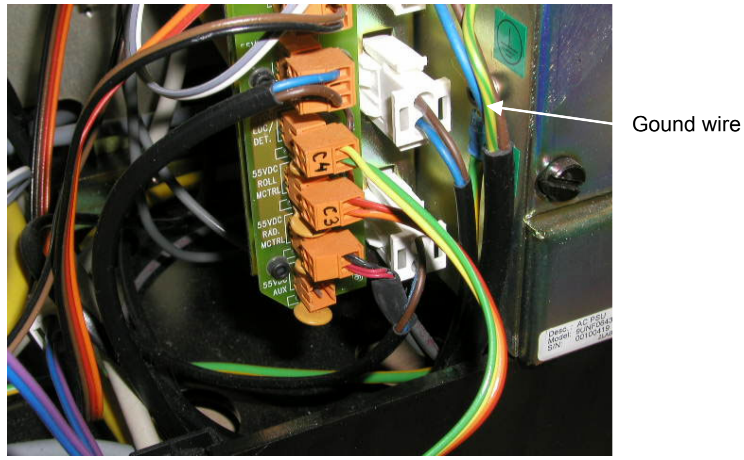
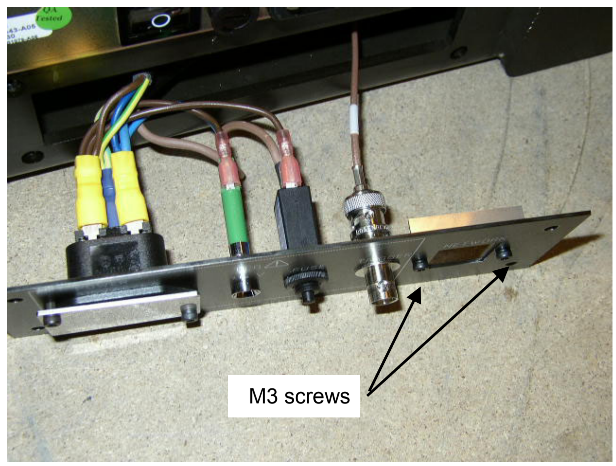
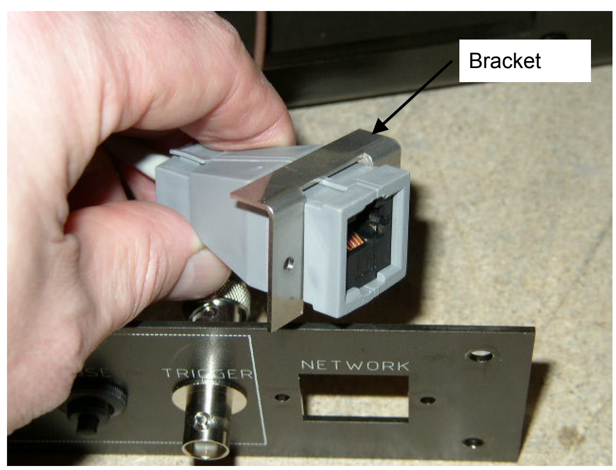
WARNING

Never route the gantry-PC interface cable together with any other cables. Due to safety and EMC/EMI considerations, the cable connecting the acquisition PC to the gantry *must* be routed in separate wiremolds.

Procedure	***Details***
6. Use a part of the rubber protector supplied with the system to protect the cable from the wall to the gantry. 3 m (10 ft) of rubber cable protectors are provided to cover cables running from the gantry to the wall (power and network cables) and the cable between gantry and PC. The cable protectors should be applied where traffic across cables must be expected. 7. Cut cable protectors to desired lengths. Open the membrane at the base of the protector to slide in the cable.	

Connect the gantry-PC interface cable to the gantry as follows:

Procedure	***Details***
8. Push the cable coming from the acquisition PC through the entry hole in the gantry. 9. Fasten the plate to the gantry using the M4 x 8 screws.	
10. Connect the hand-controller/LED/E-stop cable to the DB25 connector on the internal connector panel. 11. Connect the power cable to the IEC connector. 12. Connect the FireWire cable to any of the ports on the FireWire hub.	

Procedure	***Details***
13. Attach the eye terminal of the yellow/green ground wire to the ground screw on the power supply frame.	
14. Remove the rear connector panel for the ECG gate by unscrewing the four M4 x 8 screws holding the panel. 15. Unscrew the two M3 screws to remove the small bracket for the Ethernet connector	
16. Place the bracket on the Ethernet connector and mount the connector to the rear panel. 17. Mount the panel again on the rear of the table console.	

Note. Strain relief should be added to the gantry-PC interface cable as follows:

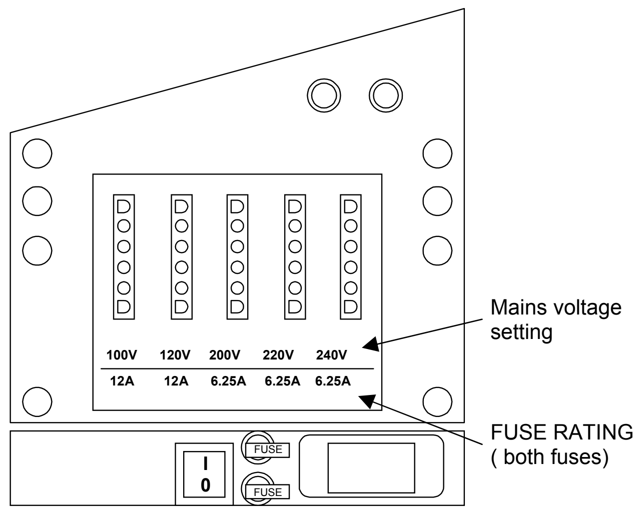
Procedure	***Details***
18. After making all connections, take all excess cable length to the interior of the gantry.	

Procedure	*Details*
19. To prevent cable connections from being stressed, attach two large Ty-Wraps to the cable on the inside of the cabinet.	

8.3.3.23 Mains Voltage Configuration

Procedure | *Details*

1. From the rear of the table console, remove the rectangular plate on the AC power supply.
2. Place the plug in the socket with the closest match to the actually measured mains voltage.
3. Verify that both fuses match the rating at the selected socket. Leave the alternatively rated fuses in the plastic bag in the bottom of the voltage selector compartment.



If configuring power for the final installation, the remaining fuses should be discarded. This is to ensure they are not mistakenly used as a replacement fuse as they will have the wrong value for the power setting.

4. Remount the rectangular cover plate.

Note.

Nominal mains voltage	*Setting*
90 – 107 V AC	100 V
108 – 132 V AC	120 V
180 – 208 V AC	200 V
209 – 228 V AC	220 V
229 – 264 V AC	240V

5. Connect the CardioMD system's power cord to the mains supply.

Note. The power cord provided with the system is an unterminated cord. The mains wiring is approved to be supplied, either via a plug into a wall outlet or hardwired to the installation.

Procedure	*Details*
6. Power up the system.	

8.3.3.24 Tightening the Rear Anchor Bolts and Testing Motion

Procedure	*Details*
1. Use the hand controller to move the detectors up and in towards the patient table, leaving the x-axis approximately 8" (20 cm) from the rear of the table.	
2. Tighten the 2 rear anchor screws using a 10 mm Allen key.	
3. Using the hand controller, check that the system will move along all axes.	
4. Leave the detector assembly in the top position in order to be able to remove the detector insulation.	

8.3.3.25 Removing Detector Insulation

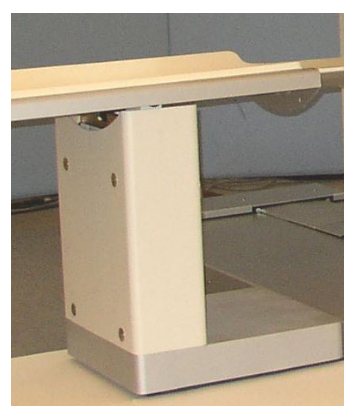
The system must stabilize to room temperature before the detector insulation can be removed. Otherwise, there is a risk of damage to the crystal.

WARNING

The thermal protection must never be removed before the detectors have been in a controlled environment and the detectors have reached room temperature. It is suggested to allow the detector temperature to stabilize for a period of 24 hours with the thermal protection on the detector if the equipment is being relocated from one temperature to an extremely different temperature environment.

The accepted rate of change should be less than 15° F (8° C) per hour. Do not locally heat or cool the detector so as to produce gradients greater than 5° F (3° C) across the detector face. Failure to comply may result in detector crystal breakage.

8.3.3.26 Mounting the Patient Table and Adjusting the Table Support

Procedure	*Details*
1. Use 8 pcs. M8 low-head screws to mount the patient table pallet.	
2. Adjust the two feet under the table support to allow the table pallet to rest on the rollers.	 

8.3.3.27 Checking Motion Limits

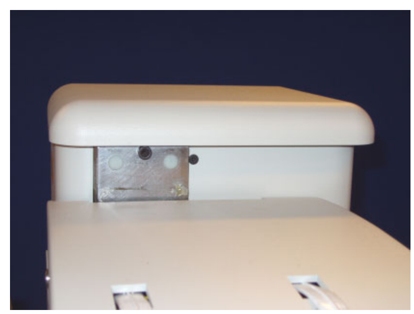
Follow instructions provided in Chapter 4 *Calibration* to check that the motion limits are properly set. If not, calibrate the motion limits, again following instructions given in Chapter 4.

8.3.3.28 Mounting Stays for Base Cover

To mount the four stays that will support the gantry base cover, proceed as follows:

Procedure	*Details*
1. Locate the four stays for the gantry base cover. 2. Mount the stays to the gantry frame. **Note**. Do not use excessive force when tightening the stays as they may break if subjected to too large a torque.	

8.3.3.29 Mounting Covers

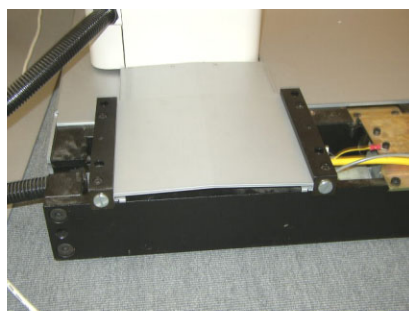
Procedure	*Details*
The cover of the tower must be removed before the base cover can be mounted. 1. Dismount the two screws at the rear: one at the bottom and one at the top of the cover. 2. Remove the tower top cover (the 'hat').	 
3. Remove the two screws on the tower's front side, again, one at the top and one at the bottom. 4. Remove the cover.	

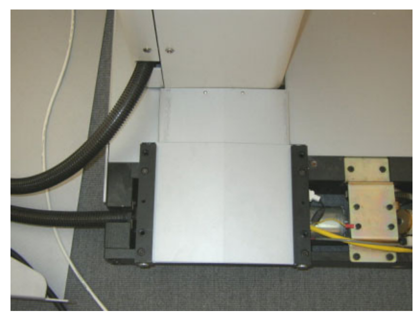
Procedure	***Details***

5. Slide in the base cover from the front.

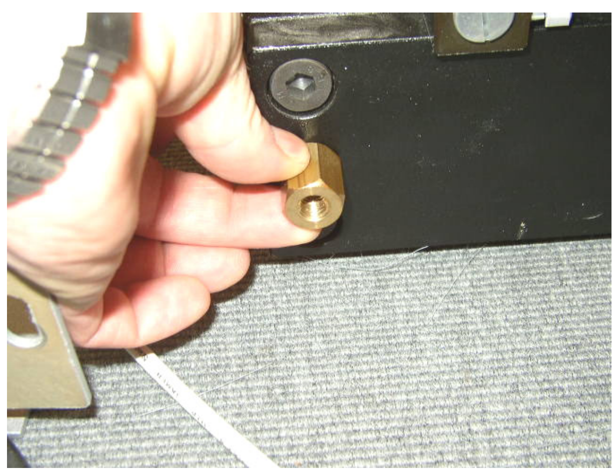
Fasten the cover:

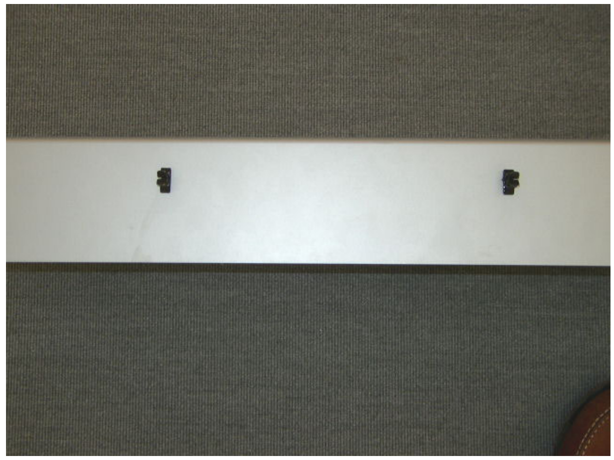
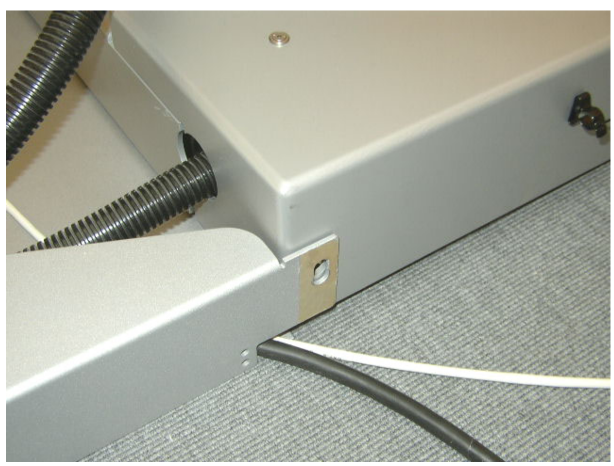
6. Mount 4 screws (and washers) from the left-hand side into the 4 stays.
7. Mount 2 screws (with washers) from the right-hand side into the base frame.
8. Re-mount the cover on the gantry tower.
9. Re-mount the tower top cover.
10. Mount the rails for the sliding cover onto the base, using 4 pcs. M6 screws and a 5 mm Allen wrench.
11. Connect the sliding cover to the tower using a 2 mm Allen wrench.





12. Mount the stay for the cable tray in the M12 hole to the left on the rear side of the gantry base.



Procedure	*Details*
13. In the rear gantry base cover, mount the two holders for the emergency crank.	
14. Mount the rear base cover onto the gantry base using 4 screws (with washers) from the top.	
15. Position the cable tray and fasten it with a M12 bottom-head cap screw and an 8 mm Allen wrench.	

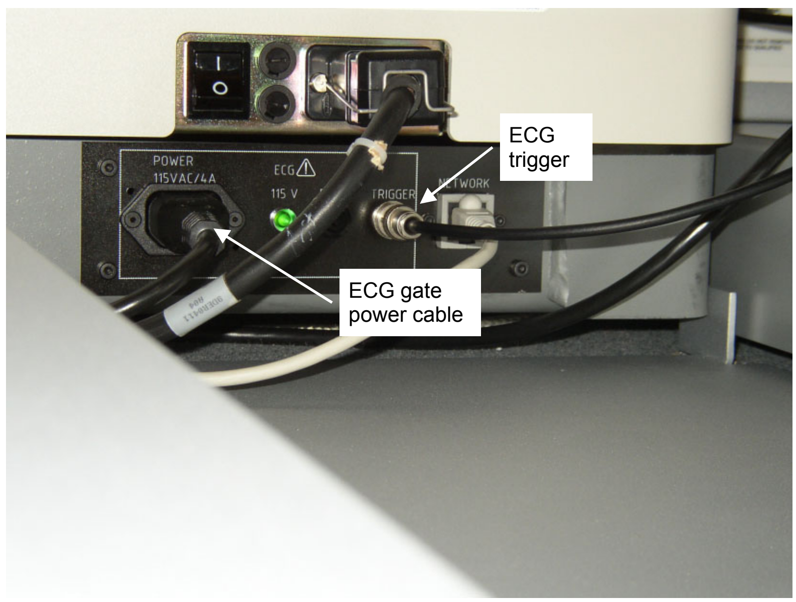
Procedure	*Details*
16. Attach the crank handle in the holders on the rear side of the gantry base.	

8.3.3.30 Setting Up the ECG Gate

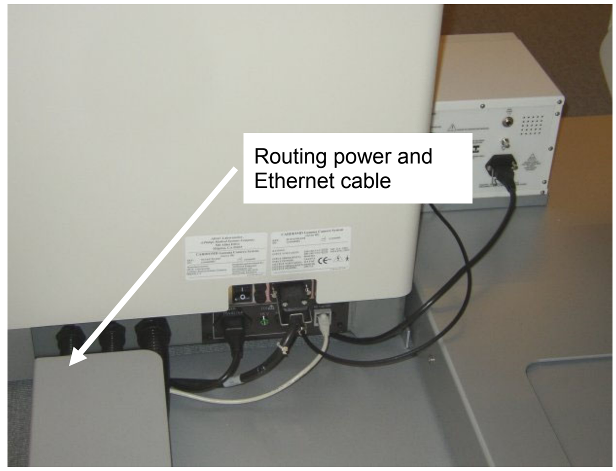
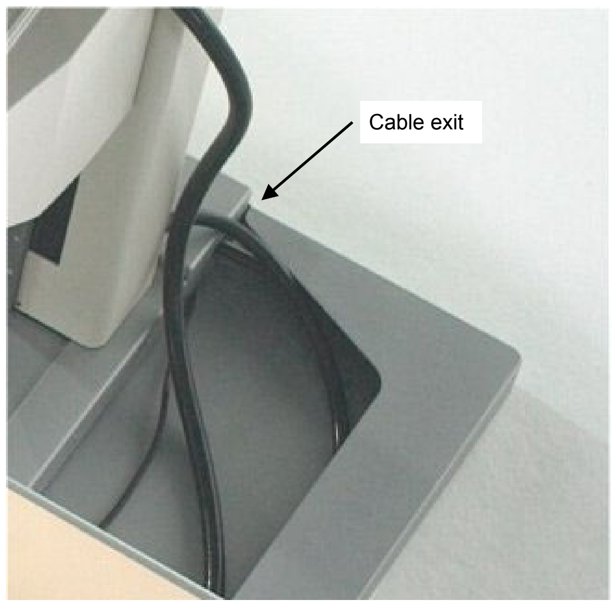
Note. The ECG gate is not shipped with the CardioMD system but is supplied separately by Philips Medical Systems.

Procedure	*Details*
1. Unpack the ECG gate.	
2. Position the ECG gate and the dedicated gate support bracket supplied with the CardioMD system next to the table console as shown in the photo on the right.	

Note. The support bracket will prevent the gate from being accidentally pushed into the detector rotation path.

Procedure	***Details***
The ECG gate connects to the panel on the rear of the table console. 3. Remove the two screws from the plate covering the ECG gate power output connector. 4. Remove the plate.	
5. Use the IEC power cable and the BNC cable supplied with the CardioMD system to connect the ECG gate to the system.	
6. Set the trigger polarity to *negative*. The trigger polarity switch is located at the rear panel of the gate.	

8.3.3.31 Protecting Power and Ethernet Cables on the Floor

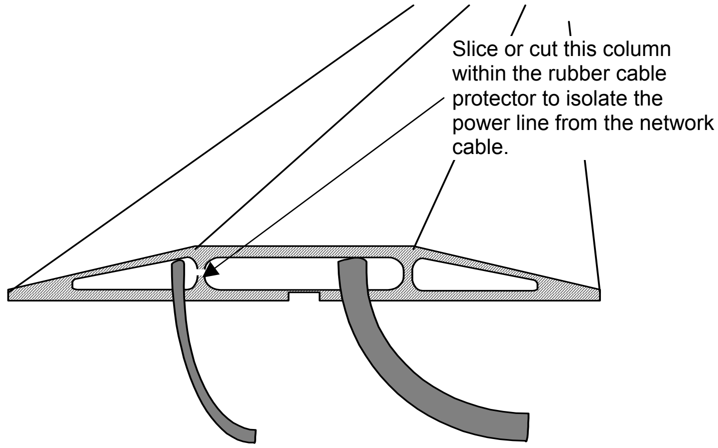
Procedure	***Details***
The power cable and the Ethernet cable can be routed in the left-hand side of the cable tray behind the table console.	
At the end facing the wall, the cable tray has a cutout that will serve as an exit point for the two cables.	

3 m (10 ft) of rubber cable protectors is provided to cover:

- Power and network cables running from the gantry to the wall
- Cable between the gantry and acquisition PC.

Routing and protecting the acquisition PC-gantry cable is described above (see page 8-46, 8-57 and 8-63).

The power and network cables running from the gantry to the wall must also be protected where traffic across the cables is to be expected.

Procedure	*Details*
1. Cut the cable protectors to the required lengths. 2. Open the membrane on the base of the protector to slide in the cables. If an insulator is required to separate the power line from the network cable: 3. Slice one of the columns inside the rubber cable protector to place one of the two cables in the side compartment.	

WARNING

Trip hazard: Failing to protect and secure the gantry-PC interface cable may cause cables to be damaged and persons to trip over the cable.

8.3.4 Software Setup

This section provides instructions for setting up software after installing the CardioMD system and laptop acquisition PC. On the laptop acquisition PC, the acquisition software runs under Microsoft Windows XP. However, this section also includes some instructions on software setup under Windows 2000 in case you need to perform these tasks on a tower acquisition PC (CardioMD Series I and II) running Windows 2000.

8.3.4.1 Local Area Network Setup

This section explains how to set up the local area network. This involves actions that may jeopardize the Windows network operation. Extreme caution must be taken when modifying the network configuration.

I, II

To perform network setup, you need administrator privileges on the acquisition PC. If your acquisition PC is running Windows XP, you automatically get administrator privileges. For Windows 2000, proceed as follows:

Procedure	***Details***
If the CardioMD acquisition is running:	
1. Ensure that the acquisition PC is displaying the Persistence page. Click the Close button in the upper right corner of the window to close the CardioMD application.	
2. Click the Windows Start button.	
3. Select **Shut Down**	
4. In the drop-down list, select **Log off CardioMD**.	
If the menu item says **Log off Administrator**, click Cancel and proceed to the section *Setting Up Acquisition PC IP Addresses* below.	
5. Click OK.	
The Log on to Windows dialog appears.	
6. In the User name field, enter `Administrator`. Ensure that the Password field is left blank.	
7. Click OK.	

Setting Up Acquisition PC IP Addresses

Contact the institution's systems administrator for setup parameters for the local area network. The network or systems administrator must provide the following information:

- An IP address for the CardioMD system
- A network node name for the CardioMD

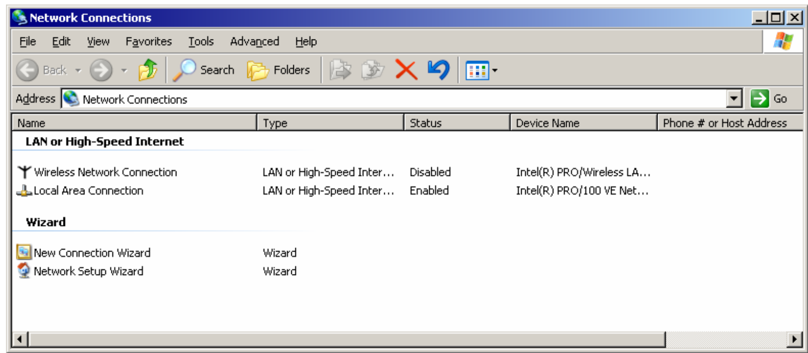
- The subnet mask setting
- The gateway IP address (if the connection between the processing station and the CardioMD acquisition PC goes via a gateway or router).

Procedure	***Details***

1. On the Windows desktop, right-click on the icon My Network Places and select **Properties** from the pop-up menu.

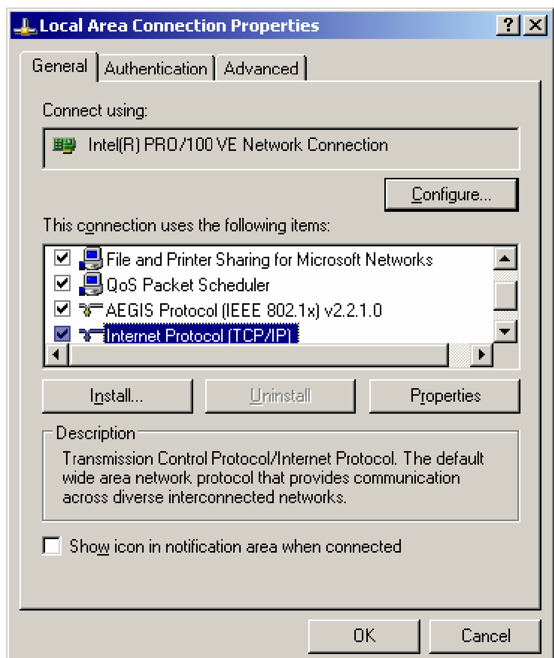
The Network Connections window appears. In Windows 2000, this window looks a little different and its name is Network and Dial-up Connections.

2. Right-click the item Local Area Connection and select **Properties** from the pop-up menu.



The Local Area Connection Properties dialog appears.

3. Select the entry Internet Protocol (TCP/IP) and click the Properties button.



Procedure ***Details***

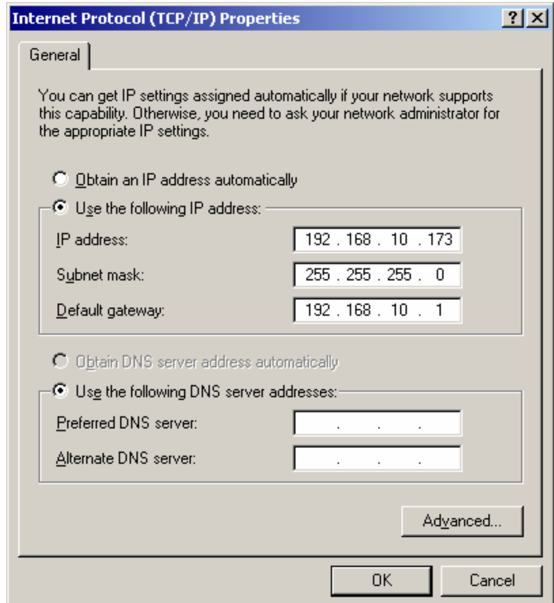
The Internet Protocol (TCP/IP) Properties dialog appears.

4. Select the radio button Use the following IP address.
5. Enter the IP address of the CardioMD system, the Subnet mask and Default gateway IP address.

Note. The IP addresses of the CardioMD system, subnet mask and default gateway must be provided by the institution's network administrator.

6. Click OK.
7. In the Local Area Connection Properties dialog, click OK again.
8. Reboot the acquisition PC.

Further information about local area network setup is available in the Windows Help system.



Setting Up the Processing Station IP Address

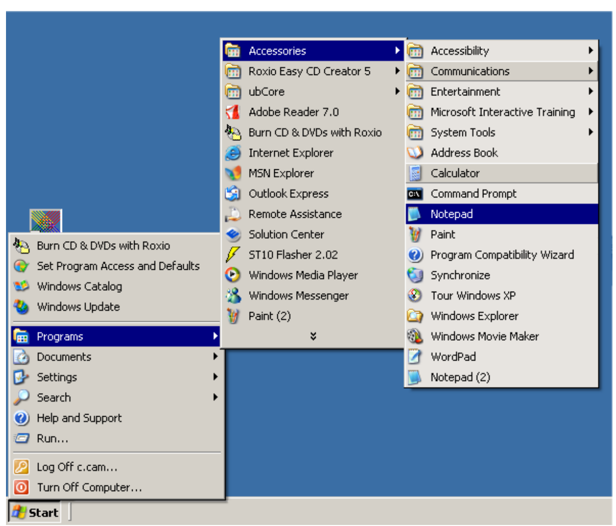
This section explains how to set up IP addresses for the processing station used with the CardioMD system. This requires editing a file named `Hosts` on the acquisition PC:

Procedure ***Details***

1. In the Windows Start menu, select **Programs**, **Accessories**, **Notepad**.

The Windows Notepad application starts.

2. In the Notepad window, select **File**, **Open**.



Procedure	***Details***

The Open dialog box appears.

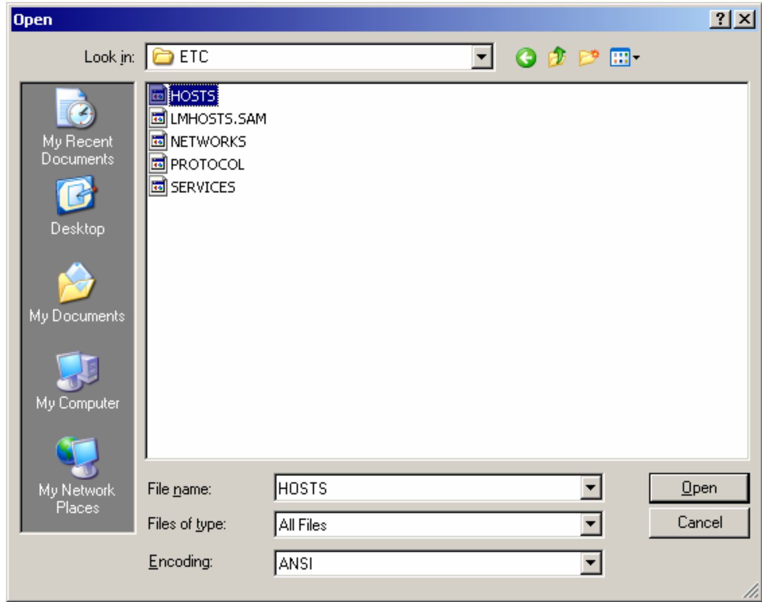
4. In Windows XP:
   Select the folder
   `C:\WINDOWS\System32\Drivers\etc`.

   In Windows 2000:
   In the Look in drop-down, select the folder
   `C:\WINNT\System32\Drivers\etc`.

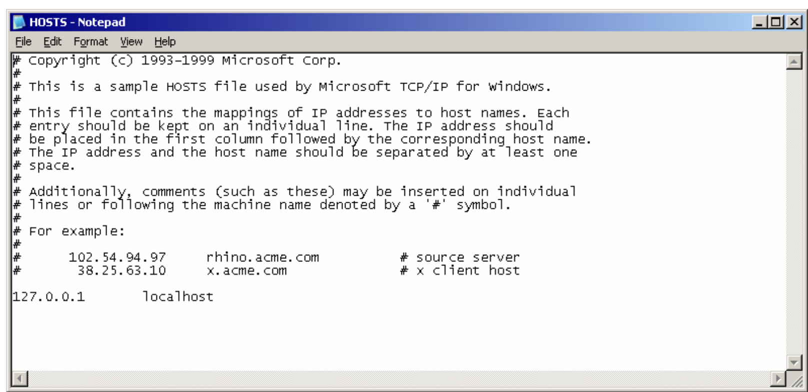
3. In the File of type drop-down, select All Files.

A listing of all the files contained in the folder appears.

4. Select the `Hosts` file and click Open.



The contents of the `Hosts` file look similar to the window shown on the right.



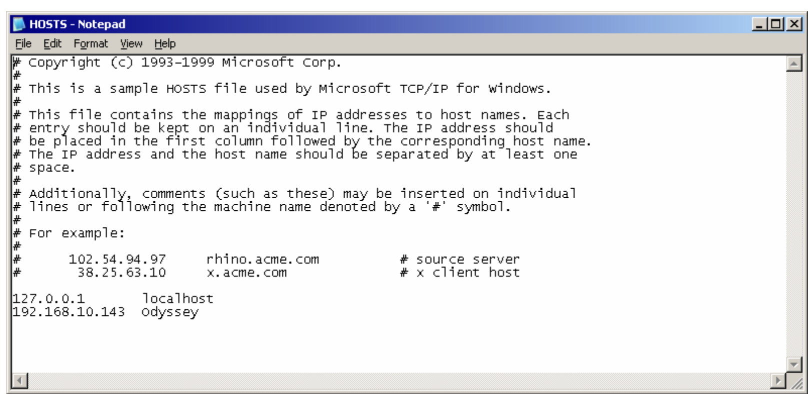
5. At the bottom of the file, add an entry for the workstation acting as the database host, starting with its IP address and ending with the hostname. For example:

`192.168.10.143 Odyssey`

Note. It is important that the IP address is valid and does not conflict with any other IP address in the network.

6. When the editing is completed, select **File**, **Save**.

7. Select **File**, **Exit** to close down the Notepad program.



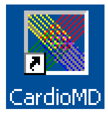
8.3.4.2 DICOM Setup

CardioMD Application DICOM Configuration

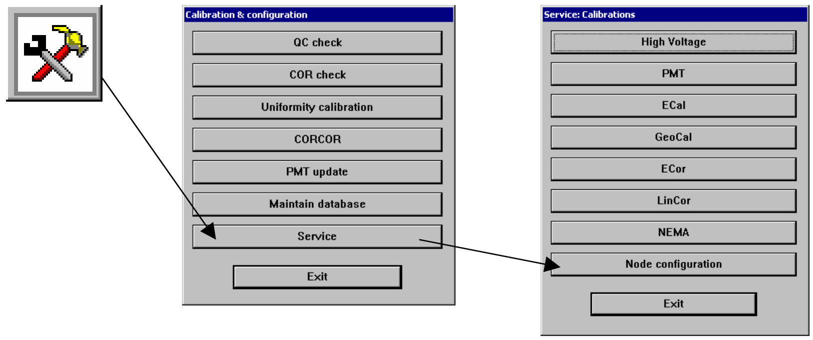
This section provides instructions on setting up communication with the processing station.

Procedure	***Details***

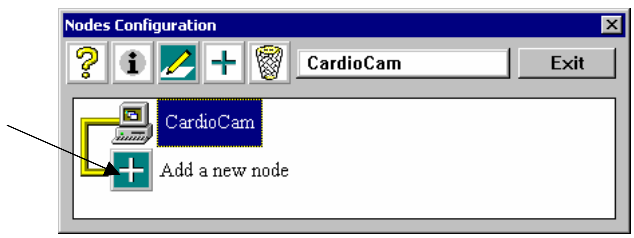
1. Double-click the CardioMD icon on the acquisition PC’s desktop to start the CardioMD application.



2. On the Persistence page, click the Tools button.
3. When the Calibration & Configuration menu appears, click Service.
4. If prompted, enter the service password (currently DDD).
5. In the Service Calibrations menu, click Node configuration.

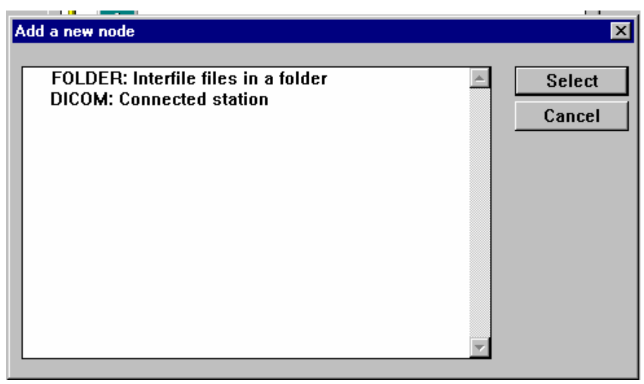


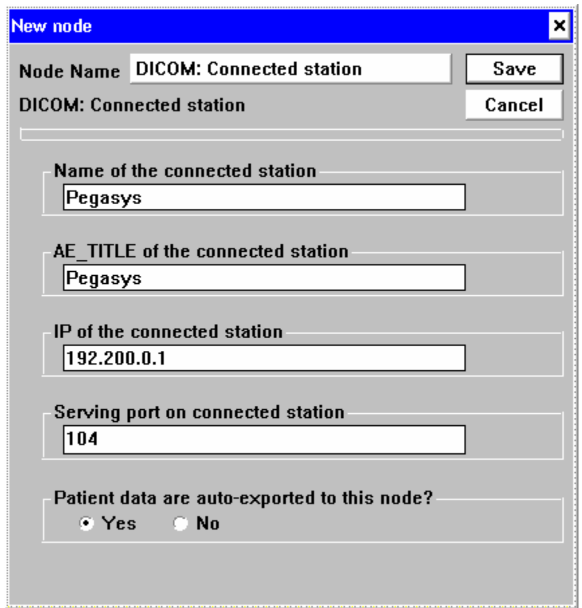
6. In the Nodes Configuration dialog, double-click the + to add a new node.



The Add a new node dialog appears.

7. Select the DICOM option and click Select.



Procedure	*Details*
The New node dialog appears. 8. Fill in the fields of the dialog as indicated in the example on the right. **Note**. The values to be entered depend on the name and IP address of the processing station. 9. To enable automatic transfer of study files to the processing station, select the Yes radio button at the bottom of the New node dialog. When this option is selected, study files are automatically exported to the processing station whenever a study is completed. Further details are available in the CardioMD Operator's Manual Chapter 4 *Operating Instructions*. 10. Click Save. 11. In the Nodes configuration dialog, click Exit. The configuration is now complete. 12. To make the changes take effect, reboot the CardioMD acquisition PC.	

DICOM Setup on the Processing Station

Please refer to the installation and/or configuration procedures in the documentation accompanying the processing station.

The DICOM configuration of the database host (host adac) must be:

Remote Server
description – CardioMD
host name – cardiomd
TCP port# - 104
Calling AE title – adac
Called AE title – PC
Query cache – 0
Host in Pegasys – yes

Local Server
description – ADAC_SCP@adac
hostname – adac IP 192.9.200.1
TCP port# – 104
Called AE title – adac
Admitted calling AE's – *
Admitted hosts – *

When the processing station has been configured, also check the DICOM transfer by exporting some of the test images located in the patient database on the acquisition PC. Follow instructions provided in the CardioMD Operator's Manual, Chapter 4 *Operating Instructions*.

DICOM Setup of JET*Stream*®

To configure the JET*Stream* Workspace properly for DICOM transfer from CardioMD, you must edit the `customMap.ini` file.

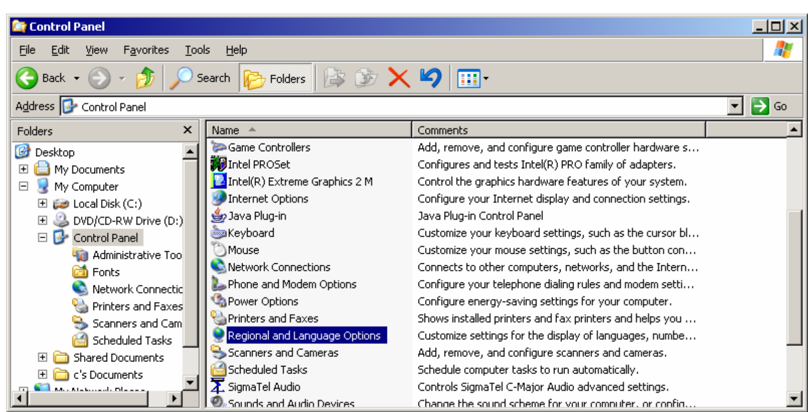
Procedure	*Details*
1. In the Windows Start menu, select **Programs**, **Accessories**, **Notepad**.	
The Windows Notepad application starts.	
2. In the Notepad window, select **File**, **Open**.	
3. Select the file `c:\Program Files\Philips Nuclear Medicine\Jetstream Workspace\dicom\customMap.ini`.	

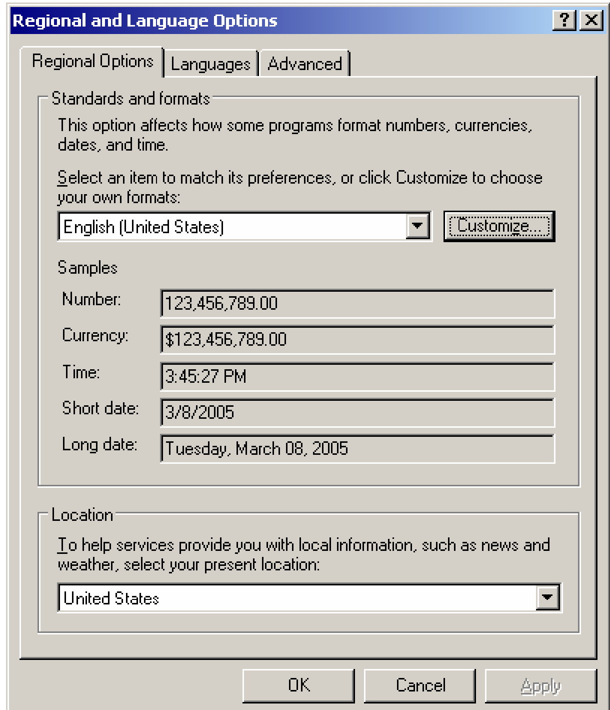
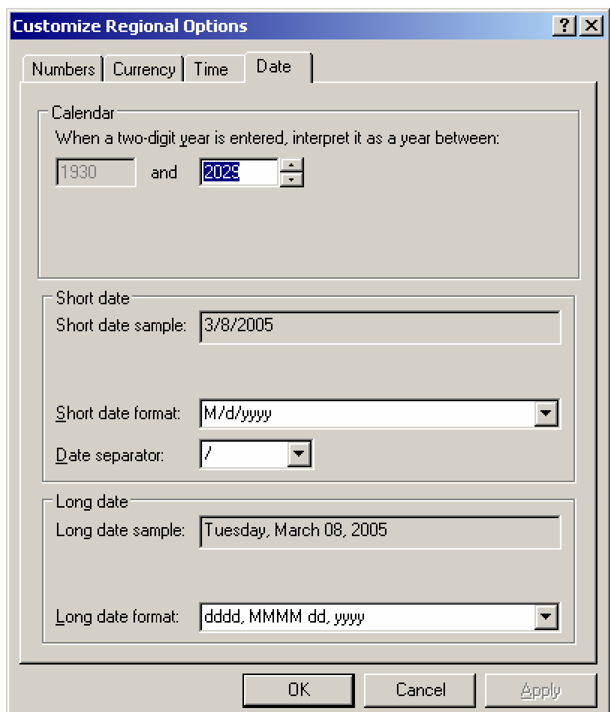
4. In this file, find the lines:
`[Philips_CardioMD]`
`NameKey = 0018,1030`
`ExamKey  = 0018,1030`	

5. Replace them with:
`[Philips_CardioMD]`
`NameKey = 0008,103e`
`ExamKey = 0018,1030`	

8.3.4.3 Configuration of Regional Settings

The acquisition PC must be set up to use the US date format (yy-mm-dd) or the international date format (dd-mm-yy).

Procedure	*Details*
1. Right-click the Windows Start button and select **Explore** from the pop-up menu.	
2. In the Explorer's folder list, select the Control Panel. 3. In the file list (the right-hand pane of the Explorer window), double-click the icon Regional and Language Options. In Windows 2000, the name of the icon is Regional Options.	

Procedure	***Details***
4. Select the appropriate language from the drop-down list. In Windows XP: 5. Click Customize.	
6. Click the Date tab. 7. In the Short date format drop-down, select the appropriate date format. Likewise, select the desired Long date format. 8. Click OK.	

8.3.4.4 Setting Up the Institution Name

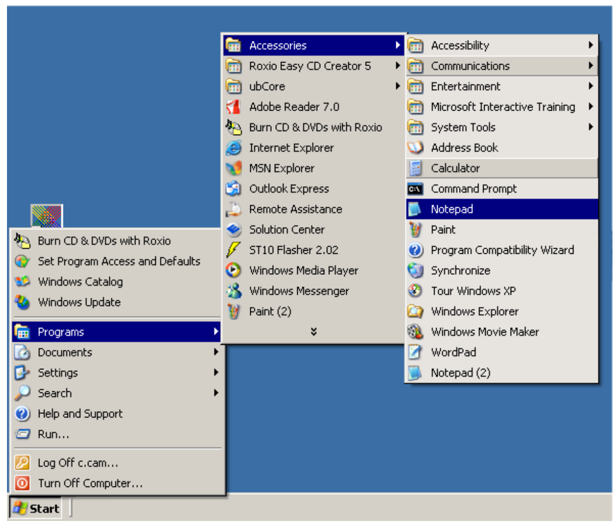
Procedure	*Details*

1. On the acquisition PC, ensure that the CardioMD application is displaying the Persistence page.
2. Click the Close button in the upper right corner of the application window to close down the application.

3. In the Windows Start menu, select **Programs**, **Accessories**, **Notepad**.

The Windows Notepad application starts.

4. In the Notepad window, select **File**, **Open**.

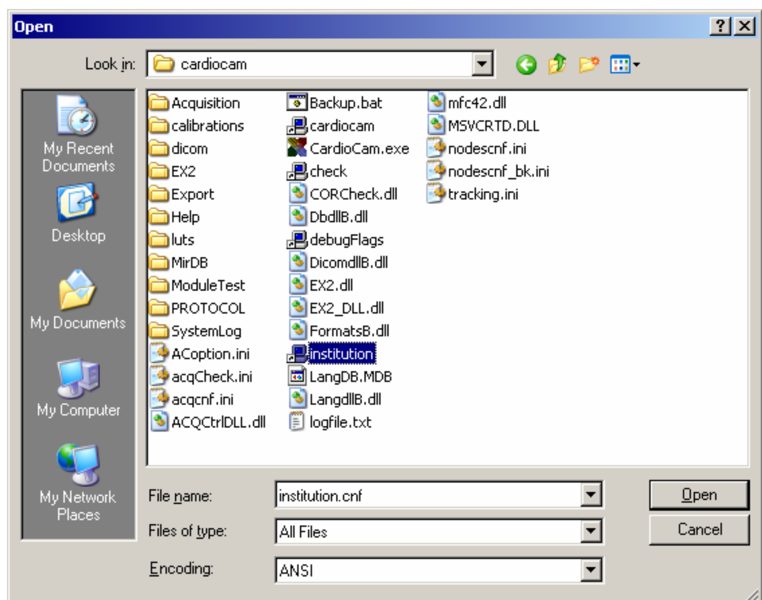


The Open dialog box appears.

5. In the Look in drop-down, select the folder `C:\cardiocam`.
6. In the File of type drop-down, select All Files.

A listing of all the files contained in the folder appears.

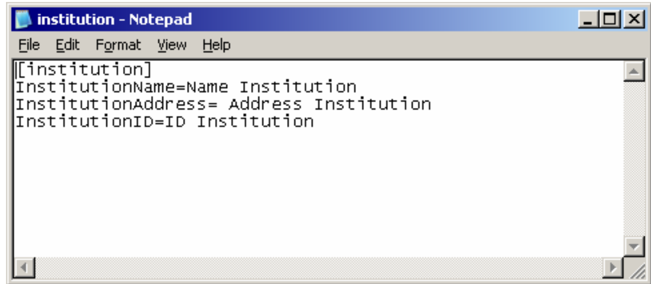
7. Select the file `institution` and click Open.



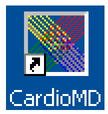
Procedure | ***Details***

The contents of the `institution` file look similar to the example shown to the right.

8. Edit the institution name, address and ID.
9. Select **File**, **Save** to save the modified file.
10. Select **File**, **Exit** to close down the Notepad program.



11. Double-click the CardioMD icon on the desktop to start the CardioMD application.
12. Check that the correct institution name and ID appear during startup.



8.3.4.5 Setting Up Units for Patient Height and Weight

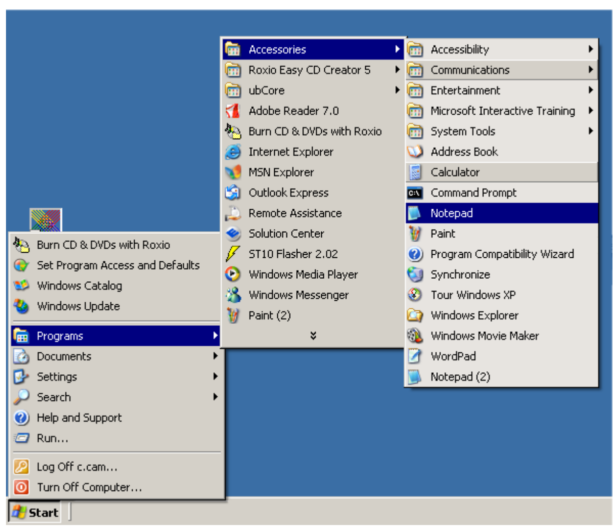
Procedure | ***Details***

1. On the acquisition PC, ensure that the CardioMD application is displaying the Persistence page.
2. Click the Close button in the upper right corner of the application window to close down the application.

3. In the Windows Start menu, select **Programs**, **Accessories**, **Notepad**.

The Windows Notepad application starts.

4. In the Notepad window, select **File**, **Open**.



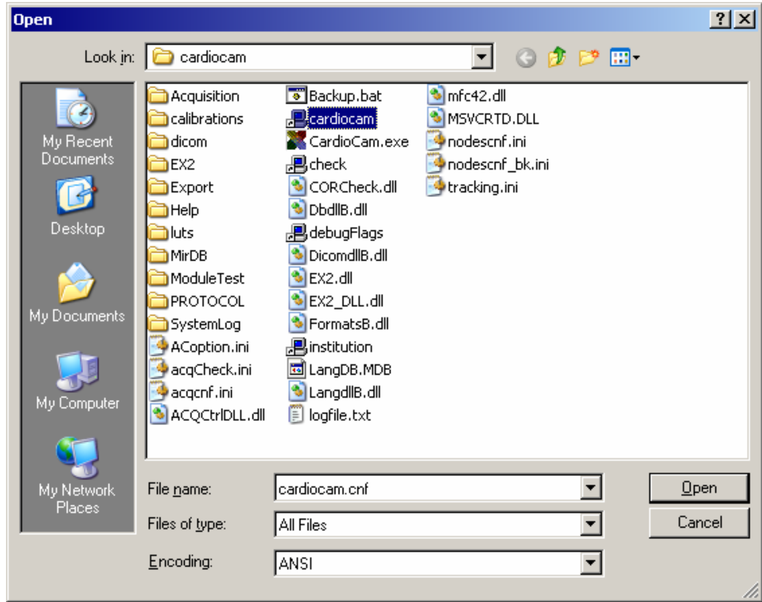
Procedure	*Details*

The Open dialog box appears.

5. In the Look in drop-down, select the folder `C:\cardiocam`.
6. In the File of type drop-down, select All Files.

A listing of all the files contained in the folder appears.

7. Select the file `cardiocam` and click Open.

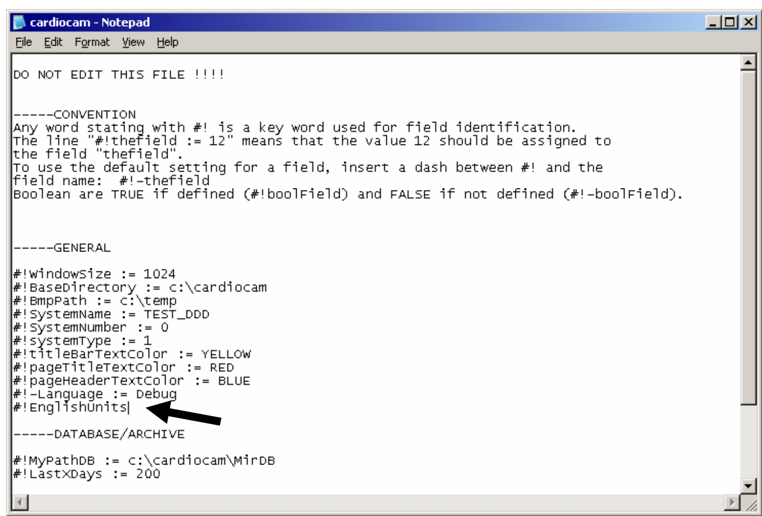


The contents of the `cardiocam` file look similar to the example shown on the right.

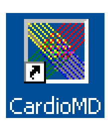
8. Find the entry `#!EnglishUnits` and edit it as follows:
   `#!EnglishUnits` configures the patient database to accept lbs., feet and inches.
   `#!-EnglishUnits` configures the patient database to use metric units.

Note. Do *not* edit any other entry of this file.

9. Select **File**, **Save** to save the modified file.
10. Select **File**, **Exit** to close down the Notepad program.



11. Double-click the CardioMD icon on the desktop to start the CardioMD application.



To check that the correct units are being used in the patient database:

12. Create a new patient entry. Follow instructions in the CardioMD Operator's Manual Chapter 4 *Operating Instructions*.

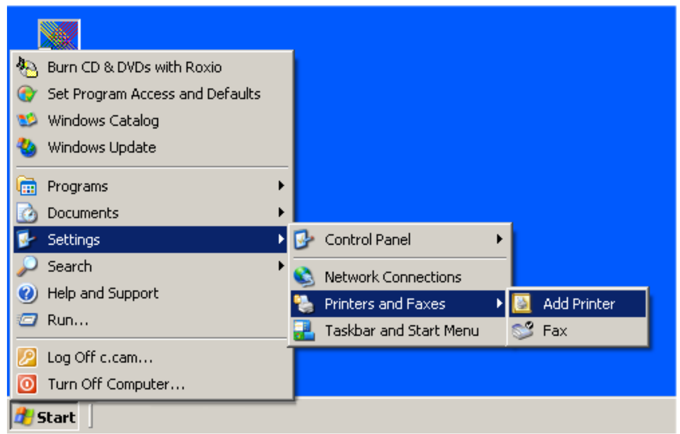
8.3.4.6 Setting Up a Hardcopy Printer

Procedure | ***Details***

1. On the acquisition PC, ensure that the CardioMD application is displaying the Persistence page.
2. Click the Close button in the upper right corner of the application window to close down the application.

In Windows XP:

3. In the Windows Start menu, select **Settings**, **Printers and Faxes, Add Printer**.



In Windows 2000:

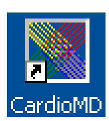
3. In the Windows Start menu, select **Settings**, **Printers**.

The Printers and Faxes window appears, showing an overview of the printers defined on the system.

4. Double-click Add Printers.
5. Follow instructions provided to create a new printer.
6. Make sure to specify that the new printer will be used as the system's default printer.

Note. The printer must be added as a network printer. A local printer, connected directly to the acquisition PC, is not supported and is not a valid configuration.

7. Double-click the CardioMD icon on the desktop to start the CardioMD application.



8. Check that the hardcopy printer is working.

For example, load a study in the patient database to the Reviewing page and click the Print button to perform a hardcopy of the study. See the CardioMD Operator's Manual Chapter 4 *Operating Instructions*.

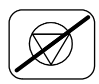
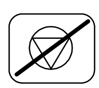
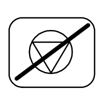
8.4 Final System Calibration and Performance Testing

Refer to Chapter 3 *Getting Started* in the CardioMD Operator's Manual for information on system startup.

Once the CardioMD system has been installed and powered up, the laptop PC has been powered up and the CardioMD application software is running, the following checks must be performed in order to verify the correct operation of the CardioMD system.

8.4.1 Checking Status LED's

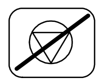
Check that the three LED's on the LED panel next to the acquisition PC correctly indicate the state of the CardioMD system:

Procedure	***Details***
After the CardioMD has been powered up:	
1. Ensure that Collision Override has been pressed as part of normal power-up procedure.	
2. Check that the Collision LED and the E-Stop LED are both OFF.	
3. Check that the green Power OK LED is ON.	
4. Activate one of the system's collision sensors.	
5. Check that the yellow Collision LED is ON.	
6. Check that the green Power OK LED is OFF.	
7. Press Collision Override on the hand controller.	
8. Check that the yellow Collision LED is OFF.	
9. Check that the green Power OK LED is ON.	
10. Activate one of the E-Stop buttons.	
11. Check that the yellow E-Stop LED is ON.	
12. Check that the green Power OK LED is OFF.	
13. Reset the E-Stop button and press Collision Override on the hand controller.	
14. Check that the yellow E-Stop LED is OFF.	

Procedure	***Details***
15. Check that green Power OK LED is ON.	

8.4.2 E-Stop Function

Check the function of both E-stop buttons:

Procedure	***Details***
1. Activate the E-Stop button.	
2. Check that the gantry cannot be moved by using hand controller motion buttons.	
3. Reset the E-Stop button and press Collision Override on the hand controller.	
4. Check that the gantry can be moved by means of hand controller motion buttons.	

8.4.3 Detector Calibration

Procedures for detector calibration are given in Chapter 4 *Calibration* of this Service Manual. Perform the following calibration procedures:

- HV calibration
- PMT update tune
- Uniformity calibration for Tc-99m
- Center of rotation calibration (for all collimators used for tomography).

Run the following performance tests described in the Operator's Manual Chapter 5 *Maintenance* to verify performance:

- QC check using Tc-99m
- New uniformity calibration for Tc-99m if the QC check indicates that this is required
- Center of rotation analysis (COR check – for all collimators used for tomography).

Procedures for performance tests are also given in Chapter 4 of this manual. NEMA tests are covered in Chapter 10 *NEMA Performance Measurement*.

9 SPARE PARTS

Contents

9.1 Spare Parts Listing

9.1.1 Detector

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
2163-5496	9SER0791-A	PMT & LIGHT SEAL KIT[1]	I, II, III	48
2163-5427	9DXE0715-B	X-E STRIP	I, II, III	2
2163-5428	9DRY0714-B	Y STRIP	I, II, III	2
2163-5429	9DRT0713-B	TUNE STRIP	I, II, III	2
2163-5430	9STB0712-A	POWER STRIP	I, II, III	2
2163-5431	9STB0716-A	PMT STRIP	I, II, III	2
2163-5433	9CSY0900-D[2]	EDC BOARD	I, II, III	2
DDD9FAN1251A	9FAN1251-A	EDC FAN SERVICE KIT	I, II, III	NA
2163-5432	9PSU0934-A	DETECTOR PSU ASSY	I, II, III	1
DDD6TAP0321A	6TAP0321-A	SEALING INSEAL 3259 1,5X30mm	I, II, III	400 cm
DDD4CSY1277A	4CSY1277-A	SEAL FOR PMT SUPPORT PLATE	I, II, III	2
2163-5479	4CSY1299-A	8.5 mm CRYSTAL (Old version)	I	2
DDD4CSY1299B	4CSY1299-B[3]	8.5 mm CRYSTAL (New version)	I	2
DDD4CSY1954A	4CSY1954-A[4]	9.5 mm CRYSTAL	II, III	2
2163-5492	9COL0889-A	DETECTOR ID BOARD	I, II, III	2
2163-5487	9CBL0871-A	INTERNAL HV CABLE	I, II, III	2
2163-5486	9CBL0868-A	COLLISION BOARD CABLE	I, II, III	2
2163-5481	9CBL0659-A	DETECTOR LV CABLE	I, II, III	2
2163-5485	9CBL0718-A	EXTERNAL HV CABLE	I, II, III	2
2163-5488	9CBL0873-A	TUNE CONTROL CABLE	I, II, III	2
2163-5459	3CBL1542-A	FIREWIRE CABLE	I, II, III	1
2163-5463	9CBL0870-A	CANBUS CABLE	I, II, III	1
2163-5483	9CBL0661-A	EDC POWER CABLE	I, II, III	2
2163-5482	9CBL0872-A	ANALOG SIGNAL CABLE	I, II, III	2
2163-5489	9CBL0875-A	EKG CABLE	I, II, III	2
2163-5476	9TER0561-A	CANBUS TERMINATOR FEMALE	I, II, III	1
DDD4CSY1557B	4CSY1557-B	COLLISION PAD FOR DETECTOR	I, II	2
DDD4CSY1666A	4CSY1666-A	COLLISION PAD FOR DETECTOR	III	2
DDD9CBL0942A	9CBL0942-A	DETECTOR END COLLISION CABLE	I, II, III	2
DDD9CBL0943A	9CBL0943-A	DETECTOR TOP COLLISION CABLE	I, II, III	1
DDD9COL0899A	9COL0899-A	COVER COLLISION BOARD	I, II, III	2
9355-0001A	9CSY0952-A	DETECTOR COVER COLLISION SWITCH	I, II, III	2
DDD4CSY1259B	4CSY1259-B	CRYSTAL FIXATOR	I, II, III	2

[1] Two different types of PMT's exist – an old and a new type. These are interchangeable. See Figure 9.2, page 9-9

[2] EDC boards versions 9CSY0900-A through 9CSY0900-D are valid and interchangeable versions and differ only in the way software is loaded to them. See Chapter 7 *Software Update Procedures*

[3] 4CSY1299-B is larger (width and length) which makes it easier to align it during replacement. 4CSY1299-B can *only* be mounted in detectors version C

[4] 4CSY1954-A is only for detectors version D and higher

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
DDD2PMT0096A	2PMT0096-A	OPTICAL COUPLING COMPOUND	I, II, III	NA

9.1.2 Collimators

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
DDD9CSY0847D	9CSY0847-D	LEHR COLLIMATOR	I, II	2
DDD9CSY1281A	9CSY1281-A	LEHR COLLIMATOR	III	2
DDD9CSY0846D	9CSY0846-D	LEGP COLLIMATOR	I, II	Option
DDD9CSY1280A	9CSY1280-A	LEGP COLLIMATOR	III	Option
2163-5445	9COL0888-A	COLLIMATOR ID BOARD	I, II, III	2
2163-3055A	9CSY0910-A	COLLIMATOR CABINET	I, II	Option
DDD9CSY1377A	9CSY1377-A	COLLIMATOR CABINET	III	Option
DDD4CSY1271B	4CSY1271-B	COLLISION PAD FOR COLLIMATOR	I, II	2
DDD4CSY1756A	4CSY1756-A	COLLISION PAD FOR COLLIMATOR	III	2

9.1.3 Gantry

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
2163-5421	9UNF0643-A	POWER SUPPLY (MAINS UNIT)	I, II, III	1
2163-5420	9CSA0865-A	SAFETY BOARD	I, II, III	1
2163-5417	9MOT0918-B	TWO AXES MOTOR CONTROLLER	I, II, III	2
2163-5415	9CTA0858-A	TABLE DRIVE BOARD	I, II, III	1
DDD9KIT1305B	9KIT1305-B	ROLL/Y MOTOR AMPLIFIER INST. KIT	I, II, III	NA
2163-5457	9AMP0924-A	X MOTOR AMPLIFIER	I, II, III	1
DDD9SER1354A	9SER1354-A	X-DRIVE BEARING KIT	I, II, III	NA
2163-5478	2MOT1270-A	ROLL/Y HDD MOTOR	I, II, III	2
2163-5453	9CSY0987-A	X MOTOR (dunker motor)	I, II, III	1
2163-5452	2MOT0990-A	TABLE MOTOR	I, II, III	1
2163-5493	9CBL0881-A	ABS POSITION ENCODER	I, II, III	3
DDD4CSY1293A	4CSY1293-A	KEY PLATE INCL. HARDWARE	I, II, III	1
2163-5416	9CSY0761-A	SIDE CONNECTOR PANEL	I, II	1
DDD9CSY1382A	9CSY1382-A	SIDE PANEL	III	1
DDD9PAN1462A	9PAN1462-A	INTERNAL CONNECTOR PANEL	III	1
DDD9CBL0946A	9CBL0946-A	E-STOP CABLE, SHORT	III	1
DDD3HUB1732A	3HUB1732-A	FIREWIRE HUB	III	1
DDD9CBL1443A	9CBL1443-A	FIREWIRE HUB POWER CABLE	III	1
DDD9PAN1460A	9PAN1460-A	REAR CONNECTOR PANEL	III	1
2163-5494	9CBL0882-A	ULTIMATIVE STOP SWITCH	I, II, III	3
2163-5495	9CBL0883-A	ULTIMATIVE STOP CABLE	I, II, III	3
2163-5480	9CBL0531-A	HDD RESOLVER CABLE	I, II, III	2
2163-5473	9CBL0895-A	DUAL INPUT CABLE	I, II, III	1
2163-5474	9CBL0896-A	DUAL OUTPUT CABLE	I, II, III	1

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
2163-5475	9CBL0901-A	ENCODER CABLE	I, II, III	1
2163-5468	9CBL0884-A	MOTOR CABLE	I, II, III	1
2163-5470	9CBL0886-A	MOTION CONTROLLER POWER	I, II, III	2
DDD9CBL1300A	9CBL1300-A	MCTRL POWER CABLE	I, II, III	1
2163-5491	9CBL0897-A	AMC CONTROL CABLE	I, II, III	2
2163-5490	9FLT0936-A	CCAM DC FILTER UNIT	I, II, III	1
2163-5472	9CBL0891-A	CANBUS MCTR 1-2 CABLE	I, II, III	1
2163-5484	9CBL0675-A	HDD MOTOR CABLE	I, II, III	2
2163-5465	9CBL0876-A	LONG CANBUS CABLE	I, II, III	1
2163-5477	9TER0562-A	CANBUS TERMINATOR MALE	I, II, III	1
2163-5471	9CBL0887-A	TABLE DRIVE CABLE	I, II, III	1
2163-5466	9CBL0877-A	LONG EKG CABLE	I, II, III	1
2163-5467	9CBL0880-A	LONG FIREWIRE CABLE	I, II, III	1
DDD9CBL0874B	9CBL0874-B	DETECTOR POWER CABLE	I, II, III	1
2163-5462	9CBL0665-A	COPLEY AMPLIFIER CABLE	I, II, III	1
2163-5469	9CBL0885-A	SAFETY BOARD POWER CABLE	I, II, III	1
2163-5499	3FUS0284-A	FUSE LITTLE 6.25A/250V	I, II, III	2
2163-5500	3FUS1510-A	FUSE 12A/250V 6.3X32MM	I, II, III	2
2163-5501	3FUS1509-A	FUSE 10A/250V 6.3X32MM	I, II, III	2
2163-5502	4CSY1370-A	WORM WHEEL FOR ENCODER	I, II, III	2
2163-5503	2BLT1274-A	BELT SYNCROFLEX (FOR ROTATE)	I, II, III	1
2163-5508	4CSY1415-A	GEAR WHEEL FOR TABLE	I, II, III	1
DDD4CSY1414A	4CSY1414-A	TOOTHBAR FOR TABLE	I, II, III	1
DDD4UNF1091A	4UNF1091-A	WHEEL FOR TABLE SUPPORT	I, II, III	1
DDD4UNF1092A	4UNF1092-A	SHAFT FOR TABLE SUPPORT	I, II, III	1
DDD2RNG1092A	2RNG1092-A	SEEGER RING AV12	I, II, III	2
DDD4CSY1505A	4CSY1505-A	BRACKET FOR TABLE SUPPORT	I, II	1
DDD4CSY1856A	4CSY1856-A	BRACKET FOR TABLE	III	NA
DDD4CSY1495A	4CSY1495-A	SUPPORT BAR	I, II	2
DDD4CSY1507A	4CSY1507-A	SHORT DISTANCE BAR	I, II	2
DDD4CSY2100A	4CSY2100-A	SHORT TABLE SUPPORT BRACKET	III	NA
DDD4CSY2081A	4CSY2081-A	LONG TABLE SUPPORT BRACKET	III	NA
DDD4CSY1487A	4CSY1487-A	MOUNTING BAR FOR IV POLE	I, II, III	2
DDD2SCR1277A	2SCR1277-A	SCREW CAP M8X10	I, II, III	NA
DDD4CSY1508A	4CSY1508-A	NYLON WHEEL	I, II, III	2
DDD4CSY1496A	4CSY1496-A	SUPPORT BEAM	I, II, III	1
DDD2BUS1081A	2BUS1081-A	BUSHING 10MM P10	I, II, III	2
DDD2PAS1315A	2PAS1315-A	BOLT REAMED M8X12	I, II, III	2
DDD2BUS1314A	2BUS1314-A	BUSHING PAW	I, II, III	2
DDD2NUT0538A	2NUT0538-A	NUT CONTRA BRASS M8	I, II, III	2
DDD2BEA0984A	2BEA0984-A	BEARING HK	I, II, III	2
2163-5513	4CSY1540-A	CABLE TRAY	I, II	1

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
DDD4CSY2196A	4CSY2196-A	CABLE TRAY	III	1
DDD4CSY2234A	4CSY2234-A	ECG BRACKET	III	1
DDD4CSY1398B	4CSY1398-B	TIE BAR MIDDLE	I, II, II	1
DDD4CSY1397B	4CSY1397-B	TIE BAR FRONT/REAR	I, II, II	2
DDD2SCR0970A	2SCR0970-A	SCREW CAP M 10X70	I, II, II	NA
DDD2SCR0066A	2SCR0066-A	SCREW CAP M6X6	I, II, II	NA

9.1.4 Tower Acquisition PC

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
2163-5456	3ACQ1573-D[5]	TOWER ACQ PC W. WIN2000	I, II	1
2163-5454	3ACQ1537-C[6]	ACQ PC MONITOR	I, II	1
2163-5460	3KBD1443-A	ACQ PC KEYBOARD	I, II	1
2163-5455	3ACQ1508-A	ACQ PC MOUSE	I, II	1
2163-5601	9CBL0902-A	CABLE PC – GANTRY	I, II	1
DDD2DSK0475A	2DSK0475-A	3,5 " DISK	I, II	NA
2163-5458	3BRD1444-A	IEEE 1394 FIREWIRE BOARD	I, II	1
2163-3054A	2TAB1105-B	PC CART	I, II	1
2163-5514	6CBL1075-A	PC/MONITOR MAINS CABLE	I, II	2

9.1.5 Laptop Acquisition PC

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
DDD9ACQ1471A	9ACQ1471-A	LAPTOP PC, INCL POWER SUPPLY. WINXP	III	1
DDD9ACQ1475A	9ACQ1475-A	LAPTOP POWER SUPPLY	III	1
DDD9CBL1467A	9CBL1467-A	4.5 M LAPTOP – GANTRY CABLE	III	Option
DDD9CBL1442A	9CBL1442-A	10 M LAPTOP – GANTRY CABLE	III	Option
DDD3ACQ1645B	3ACQ1645-B	LAPTOP MOUSE	III	1
DDD9CSY1447A	9CSY1447-A	LAPTOP CART	III	Option
DDD9CSY1448A	9CSY1448-A	LAPTOP WALL MOUNT OPTION	III	Option
DDD9CSY1449A	9CSY1449-A	LAPTOP DESK MOUNT OPTION	III	Option
DDD9BOX1456A	9BOX1456-A	LAPTOP PC TABLE BOX	III	Option

9.1.6 Accessories and Options

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
2163-5439	2CSY1318-A	HEAD/SHOULDER SUPPORT	I, II	1
DDD2CSY1909A	2CSY1909-A	HEAD/SHOULDER SUPPORT	III	1

[5] Versions A, B, C and D are all interchangeable. Note Version A is in light gray color and versions B, C and D are black.
[6] Versions A, B and C are interchangeable. Version A is light gray, version B and C are black

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
2163-5510	4UNC1213-A	IV POLE	I, II, III	1
2163-5435	9CSY0914-A	QC KIT	I, II	1
DDD9CSY0914B	9CSY0914-B	QC KIT	III	1
2163-5437	9CSY0923-A	FOV MASK	I, II	1
DDD9CSY1381B	9CSY1381-B	FOV MASK	III	1
2163-3050A	9CSY0848-A	BAR PHANTOM	I, II, III	Option
2163-3053A	9CSY0852-A	SHORT PATIENT TABLE	I, II	Option
DDD9CSY1288B	9CSY1288-B	SHORT PATIENT TABLE	III	Option
2163-3451	4CSY1374-A	SHORT TABLE TOP	I, II, III	Option
2163-3454	4CSY1476-A	SHORT TABLE MATTRESS	I, II	Option
DDD4CSY2185A	4CSY2185-A	SHORT TABLE MATTRESS	III	Option
2163-3052A	9CSY0853-A	LONG PATIENT TABLE	I, II	Option
DDD9CSY1284B	9CSY1284-B	LONG PATIENT TABLE	III	Option
2163-3452	4CSY1375-A	LONG TABLE TOP	I, II, III	Option
2163-3453	4CSY1445-A	LONG TABLE MATTRESS	I, II	Option
DDD4CSY2184A	4CSY2184-A	LONG TABLE MATTRESS	III	Option
2163-5436	9CSY0917-B[7]	HAND CONTROLLER	I, II	1
DDD9CSY1465A	9CSY1465-A	HAND CONTROLLER 3.5 m	III	Option
DDD9CSY1395A	9CSY1395-A	HAND CONTROLLER 6 m	III	Option
DDD2TUB1933A	2TUB1933-A	TEST TUBE 10 x 11	I, II, III	1
DDD2LID1934A	2LID1934-A	LID TEST TUBE 2TUB1933	I, II, III	1
2163-5461	6CBL1080-A	ETHERNET CABLE	I, II, III	1
2163-5602	9DER0411-A	POWER CABLE	I, II, III	1
DDD3PLG1610A	3PLG1610-A	NEMA PLUG L5-20R	I, II, III	1
DDD4CSY1542A	4CSY1542-A	COR SOURCE HOLDER	I, II, III	1
DDD6CBL1536A	6CBL1536-A	UTP PATCH CABLE	I, II, III	1

9.1.7 Covers

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
DDD4CSY1274B	4CSY1274-B	DETECTOR TOP COVER	I, II	1
DDD4CSY1876A	4CSY1876-A	DETECTOR TOP COVER	III	1
DDD4CSY1522B	4CSY1522-B	DETECTOR SIDE COVER	I, II	2
DDD4CSY2092A	4CSY2092-A	DETECTOR SIDE COVER	III	2
2163-5516	2SPR1283-A	SPRING CLIP	I, II, III	4
2163-5517	2SCR0055-A	SCREW CAP M3X8	I, II, III	NA
2163-5517	4CSY1369-A	FRONT COVER FOR TOWER	I, II	1
DDD4CSY1996A	4CSY1996-A	FRONT COVER FOR TOWER	III	1
2163-5534	4CSY1512-A	BACK COVER FOR TOWER	I, II	1
DDD4CSY2179A	4CSY2179-A	BACK COVER FOR TOWER	III	1

[7] Both version A and B are valid. Version A has a 3 m cable connecting it to the gantry. Version B has a 6 m cable.

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
2163-5521	4CSY1440-A	HAT FOR TOWER	I, II	1
DDD4CSY2085A	4CSY2085-A	HAT FOR TOWER	III	1
2163-5522	4CSY1441-A	GEAR COVER	I, II	1
DDD4CSY1929A	4CSY1929-A	GEAR COVER	III	1
2163-5518	9STP0944-A	GEAR COVER COLLISION STRIPS	I, II, III	1
2163-5518	4CSY1399-A	BASE COVER	I, II	1
DDD4CSY2083A	4CSY2083-A	BASE COVER	III	1
2163-5524	4CSY1447-A	COVER FOR BASE	I, II	1
DDD4CSY2098A	4CSY2098-A	COVER FOR BASE	III	1
2163-5523	4CSY1446-A	COVER FOR X DRIVE	I, II	1
DDD4CSY2082A	4CSY2082-A	COVER FOR X DRIVE	III	1
2163-5532	4CSY1481-A	SLIDE COVER FOR X DRIVE	I, II	1
DDD4CSY1928A	4CSY1928-A	SLIDE COVER FOR X DRIVE	III	1
2163-5519	4CSY1419-A	FRONT COVER FOR TABLE FRAME	I, II	1
DDD4CSY2079B	4CSY2079-B	FRONT COVER FOR TABLE FRAME	III	1
DDD4CSY2097B	4CSY2097-B	SHORT TABLE SUPPORT COVER	III	NA
DDD4CSY1660B	4CSY1660-B	LONG TABLE SUPPORT COVER	III	NA
2163-5520	4CSY1420-A	BACK COVER FOR TABLE FRAME	I, II	1
DDD4CSY2080B	4CSY2080-B	BACK COVER FOR TABLE FRAME	III	1
2163-5533	4CSY1499-A	COVER FOR TABLE FRAME	I, II	1
DDD4CSY2095A	4CSY2095-A	COVER FOR TABLE FRAME	III	1
DDD4CSY1279B	4CSY1279-B	SHIELDING FOR COLLIMATOR	I, II	2
DDD4CSY1884A	4CSY1884-A	SHIELDING FOR COLLIMATOR	III	2
2163-5504	2SCR0337-A	M4X8 SCREW FOR COVERS	I, II, III	4
2163-5505	2SCR0088-A	M4X12 SCREW FOR COVERS	I, II, III	24
2163-5506	4WAS0553-A	WASHER FOR M4 SCREW	I, II, III	28

9.1.8 Service Tools and Spares to Service Tools

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
2163-5600	9CBL0818-A	MOTION CONTROLLER RS232 CABLE	I, II, III	1
2163-5407	9CSY0860-A	DETECTOR SERVICE KIT	I, II, III	NA
2163-5512	2PHR1382-A	DETECTOR KIT SHIPPING CASE	I, II, III	NA
2163-5526	9CSY0849-A	X-LINE PHANTOM	I, II, III	NA
2163-5529	9CSY0915-A	Y-LINE PHANTOM	I, II, III	NA
2163-5531	9CSY0850-A	GEOCAL MASK	I, II, III	NA
2163-5540	4SOU1324-A	POINT SOURCE HOLDER	I, II, III	NA
2163-5541	4UNC1470-A	TEFLON BOTTLE	I, II, III	NA
2163-5513	2POD0246-A	TRIPOD KAISER	I, II, III	NA
2163-5539	4PHA1429-A	SOURCE HOLDER FOR TRIPOD	I, II, III	NA
2163-5525	4CSY1450-A	PHANTOM FRAME	I, II, III	NA
2163-5515	2TAB0006-A	LOCK SNAP	I, II, III	NA

Philips part no.	*DDD part no.*	*Description*	*System series*	*Qty per system*
2163-5408	9CSY0859-B	NEMA KIT	I, II, III	NA
2163-5511	2PHR1381-A	NEMA SHIPPING CASE	I, II, III	NA
2163-5530	9CSY0856-A	NEMA MASK	I, II, III	NA
2163-5527	9CSY0851-A	X-LINE NEMA PHANTOM	I, II, III	NA
2163-5528	9CSY0916-A	Y-LINE NEMA PHANTOM	I, II, III	NA
DDD4CSY1278B	4CSY1278-B	INSTALLATION TEMPLATE	I, II, III	1
2163-3051A	9CSY0963-A	INST. KIT FOR OSPHOD SITE	I, II, III	Option
2163-5514	2SCR1231-A	EXPANSION ANCHOR	I, II, III	6
2163-5515	9CSY0861-A	DOLLY ASSEMBLY	I, II, III	1
DDD4UNC1290A	4UNC1290-A	DOLLY TRAPEZ	I, II, III	4
DDD2GUM0760A	2GUM0760-A	RUBBER SEALING 15X20MM	I, II, III	340 cm
DDD2RUB1246A	2RUB1246-A	CABLE PROTECTOR	I, II, III	1
DDD3ACQ1669A	3ACQ1669-A	USB-RS232 CONVERTER FOR LAPTOP	III	NA

9.2 Location of Spare Parts

9.2.1 Detector

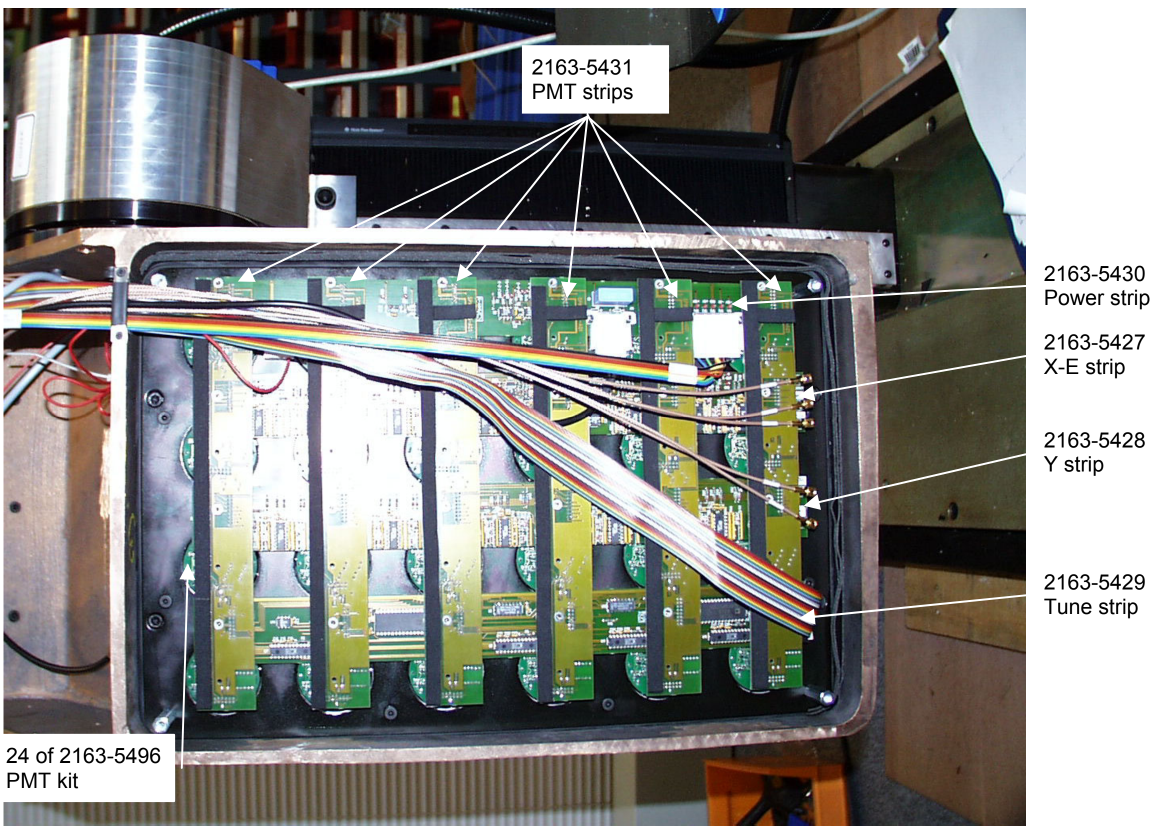


Figure 9.1 Internal strip boards and PMT's

Two types of PMT's exist for the CardioMD system, an old type and a new type. These two types of PMT's only differ in appearance and they can be interchanged and installed together in the

same detector without problems. The change of appearance has come about merely to solve problems encountered in production. See Figure 9.2.

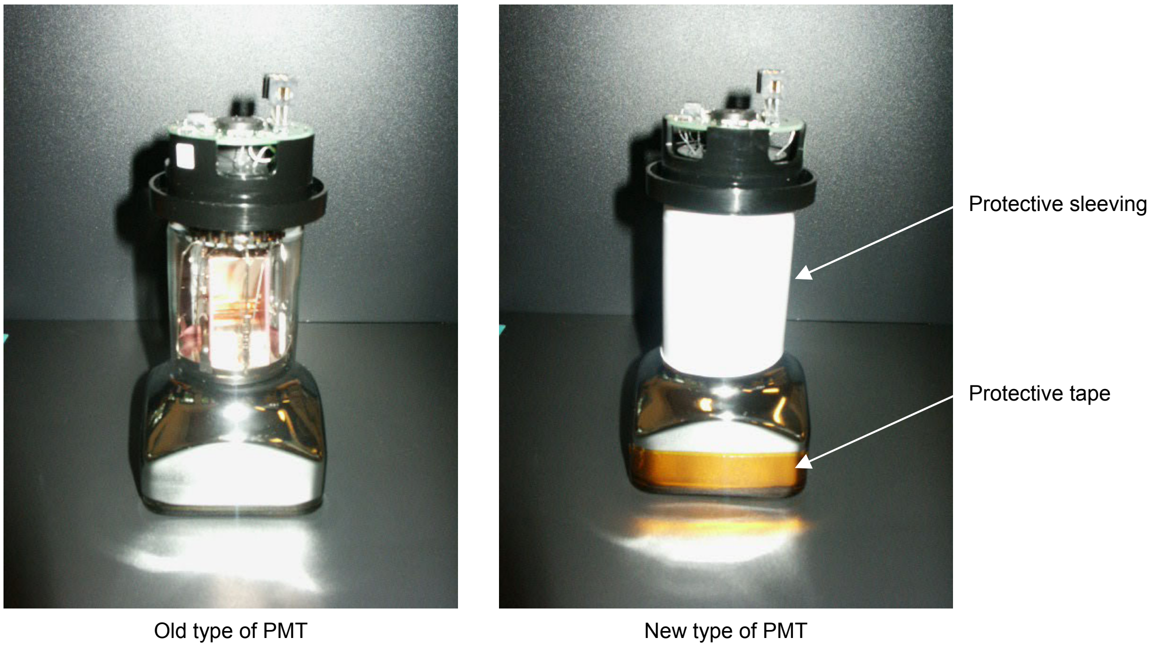


Figure 9.2 The two different types of PMT

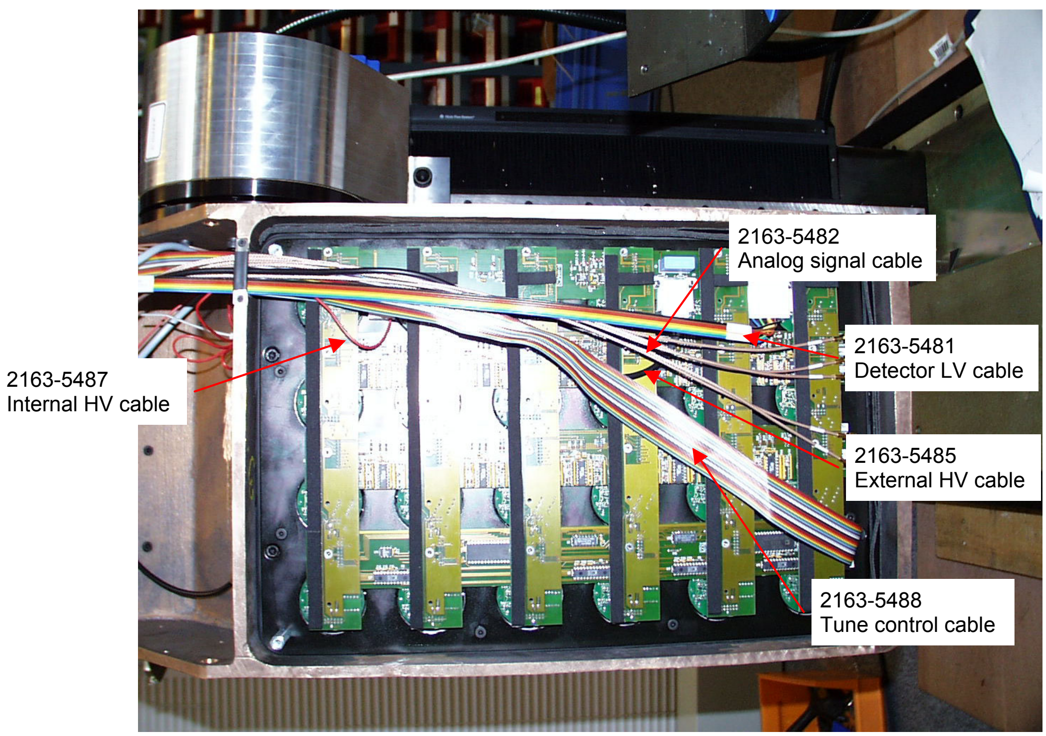


Figure 9.3 Internal cables

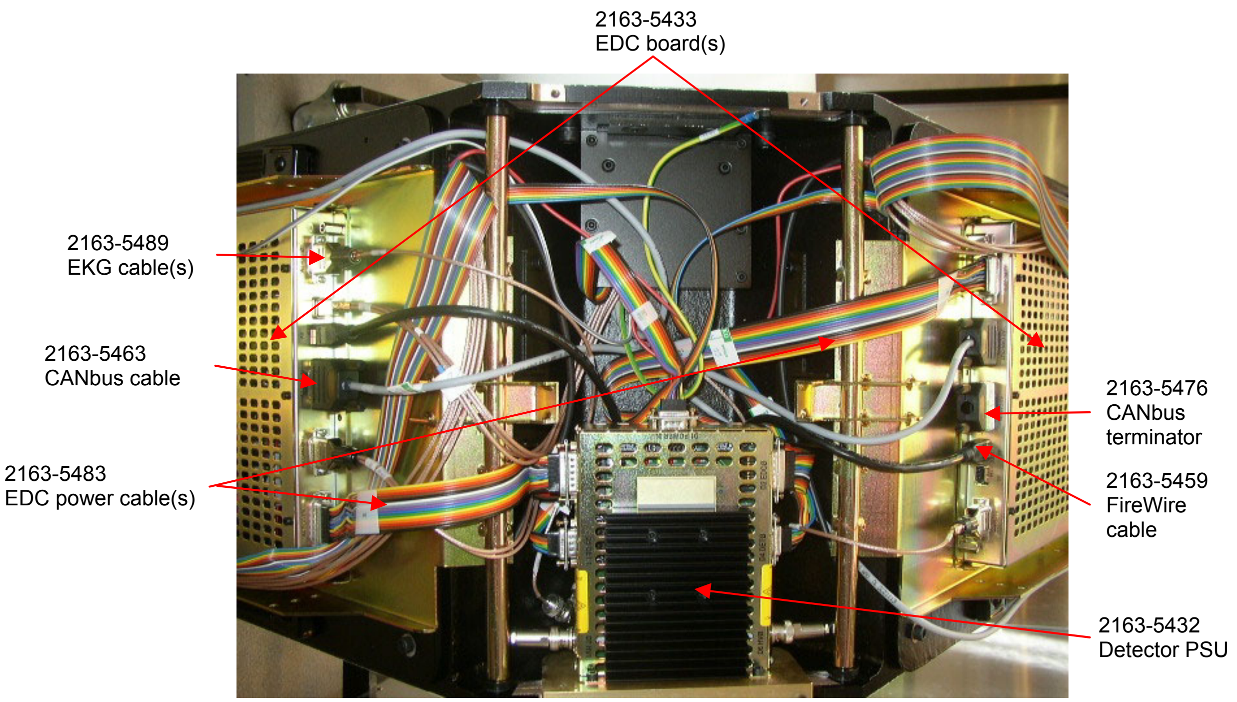


Figure 9.4 External modules

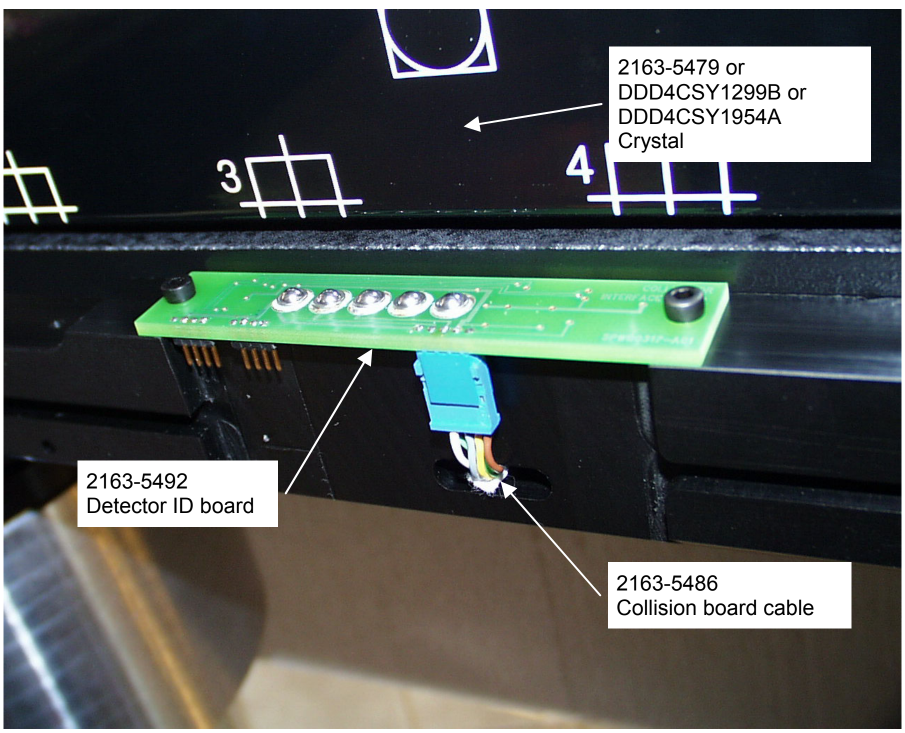


Figure 9.5 Detector ID board

Note. This figure lists DDD part numbers. Refer to section 9.1 for Philips part numbers.

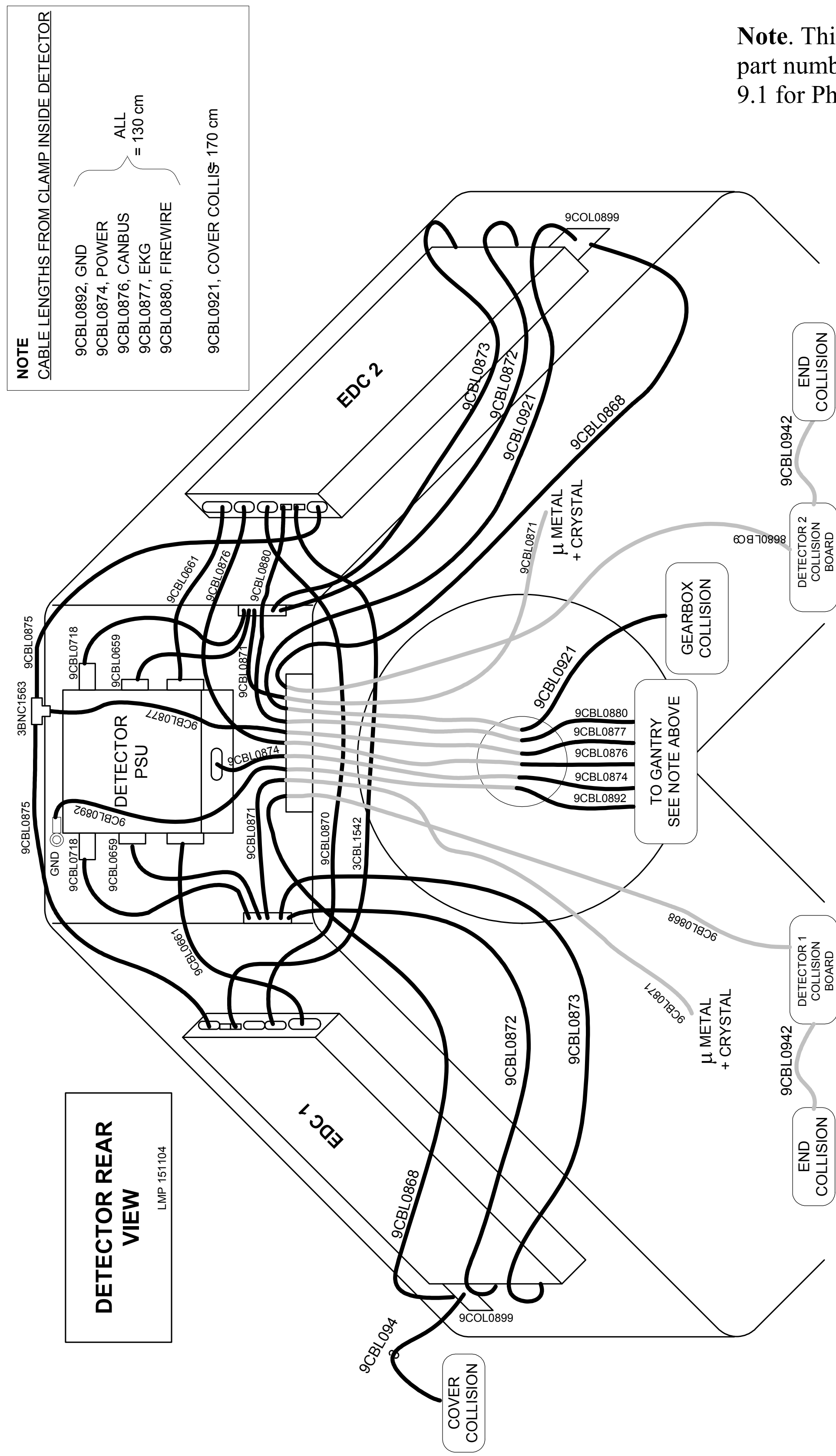


Figure 9.6 Detector cabling

I, II

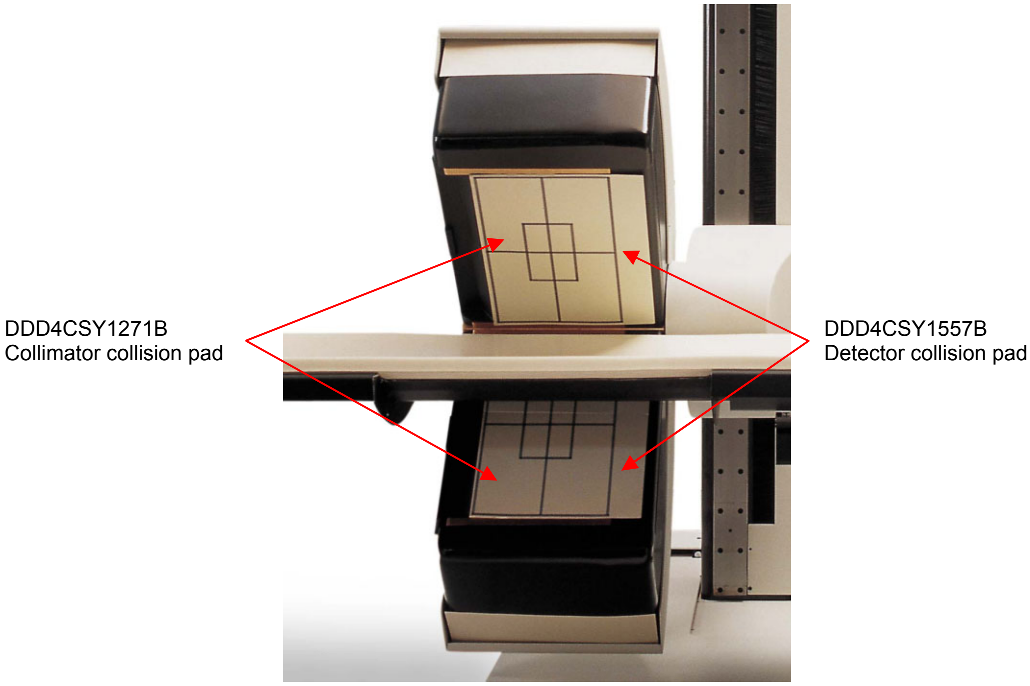


Figure 9.7 Detector and collimator collision pads (CardioMD Series I and II)

III

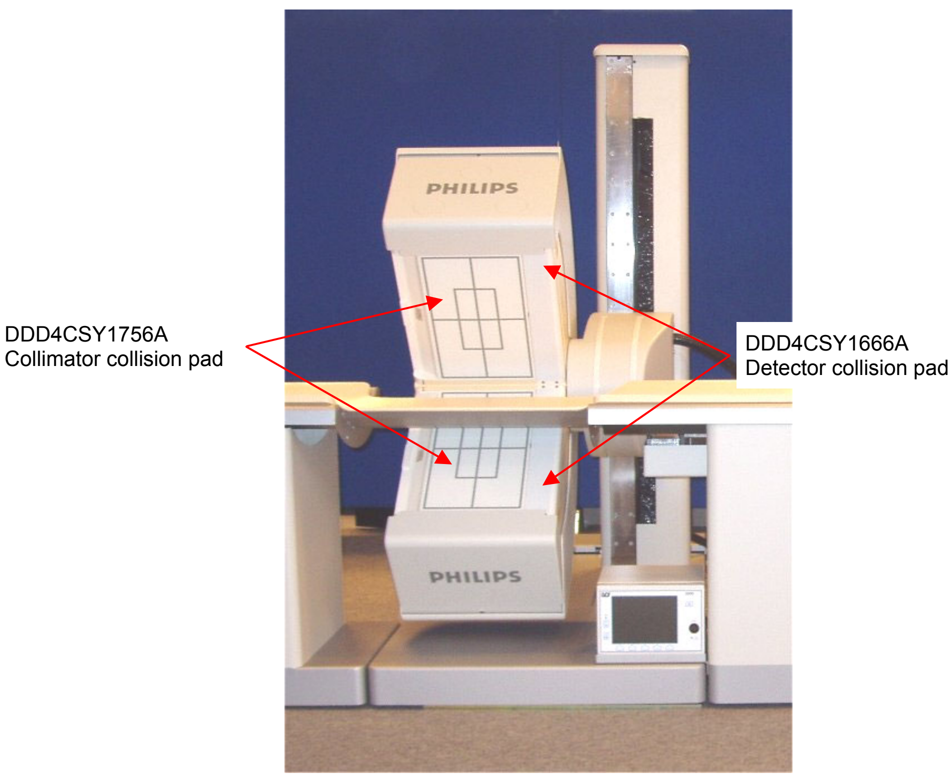


Figure 9.8 Detector and collimator collision pads (CardioMD Series III)

9.2.2 Collimators

I, II

9CSY0847 is a complete LEHR collimator (Series I and II) including the 9CSY0888 Collimator ID board.
9CSY0846 is a complete LEGP collimator (Series I and II) including the 9CSY0888 Collimator ID board.
9CSY0910 Collimator Cabinet is the complete cabinet (Series I and II) shown in Figure 9.10.

III

9CSY1281 is a complete LEHR collimator (Series III) including the 9CSY0888 Collimator ID board.
9CSY1280 is a complete LEGP collimator (Series III) including the 9CSY0888 Collimator ID board.
9CSY1377 Collimator Cabinet for Series III is very similar to Figure 9.10.

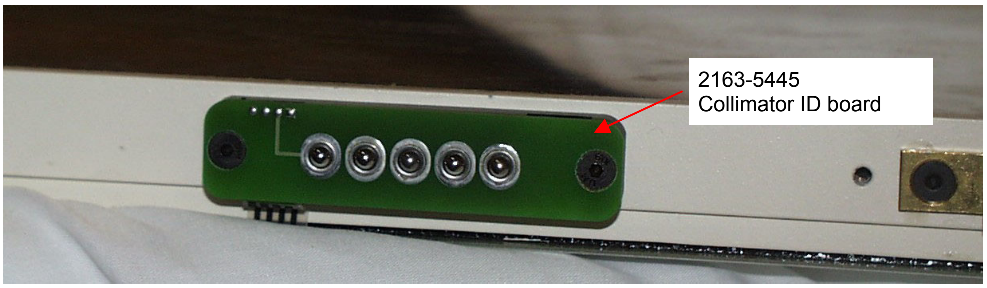


Figure 9.9 Collimator with collimator ID board

Figure 9.10 Collimator cabinet with one collimator stored

9.2.3 Gantry

To ease identifying of the location of the gantry FRU's, this section is divided into separate subsections for the gantry base, the table base (electronics cabinet) and the gantry tower.

Figure 9.11 on page 9-15 and Figure 9.12 on page 9-16 illustrate system cabling and identify all cables within the CardioMD.

I, II

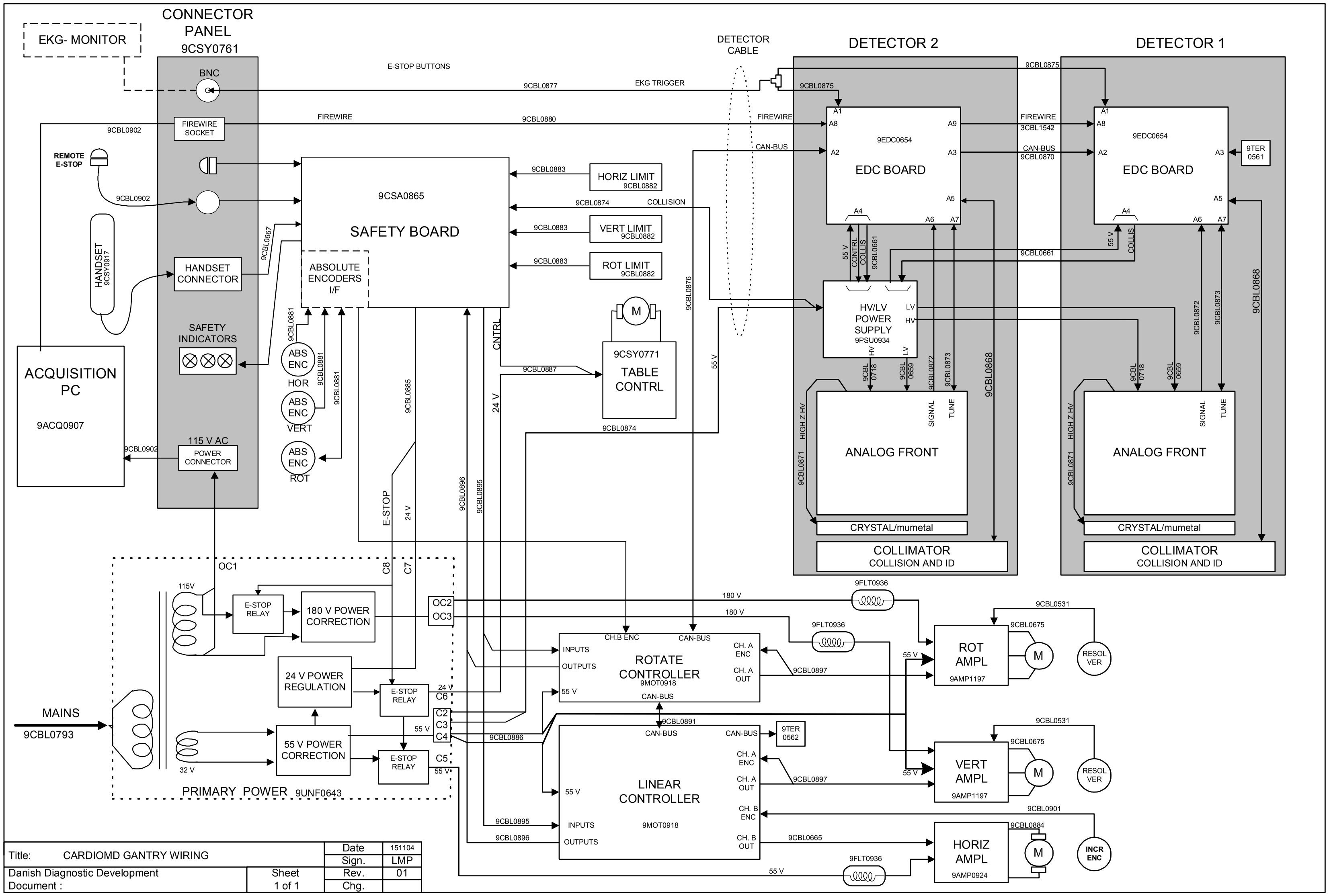


Figure 9.11 CardioMD cable overview (CardioMD Series I and II)

Note. Figure 9.11 lists DDD part numbers. Refer to section 9.1 for PHILIPS part numbers.

III

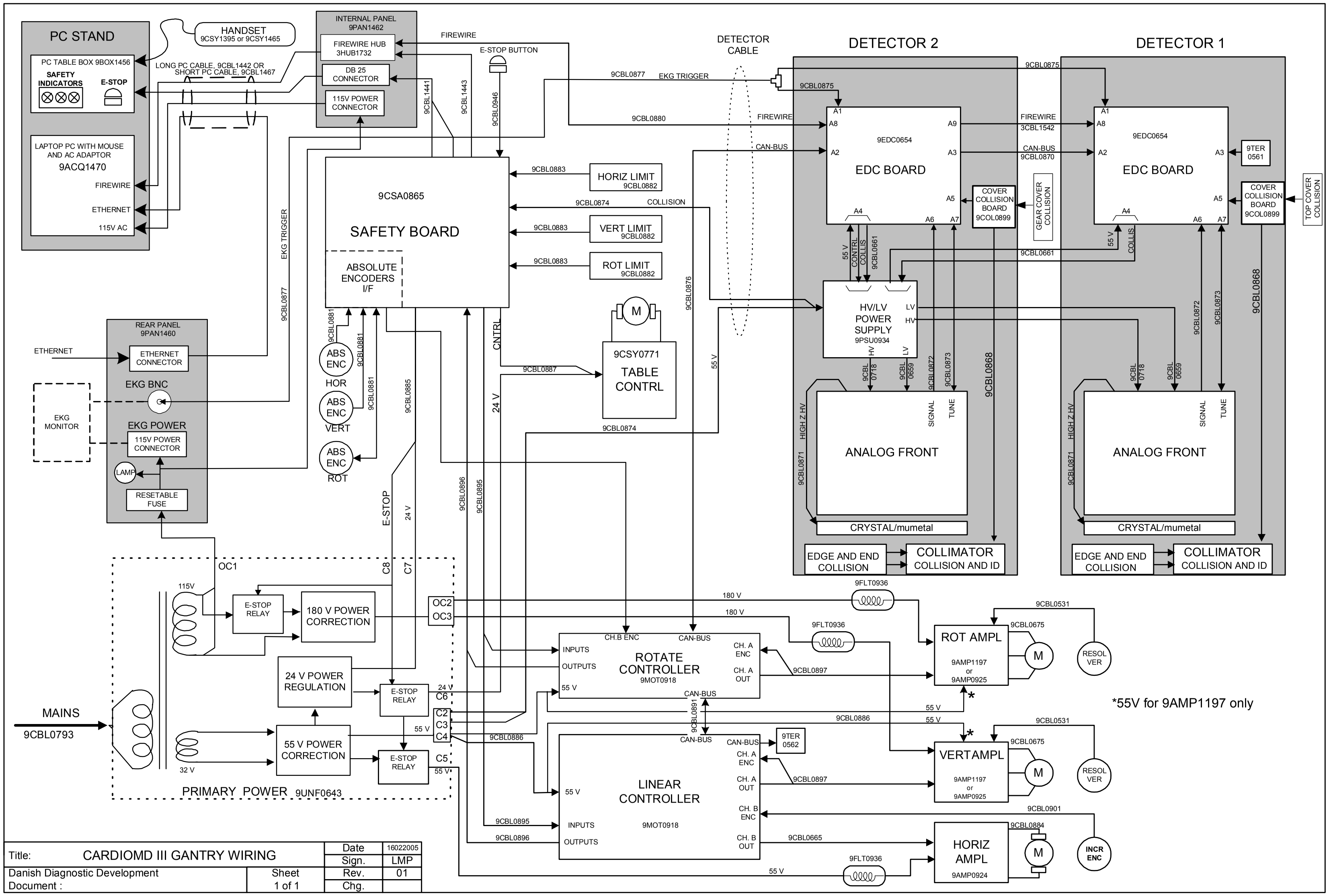


Figure 9.12 CardioMD cable overview (CardioMD Series III)

Note. Figure 9.12 lists DDD part numbers. Refer to section 9.1 for PHILIPS part numbers.

9.2.3.1 Gantry Base

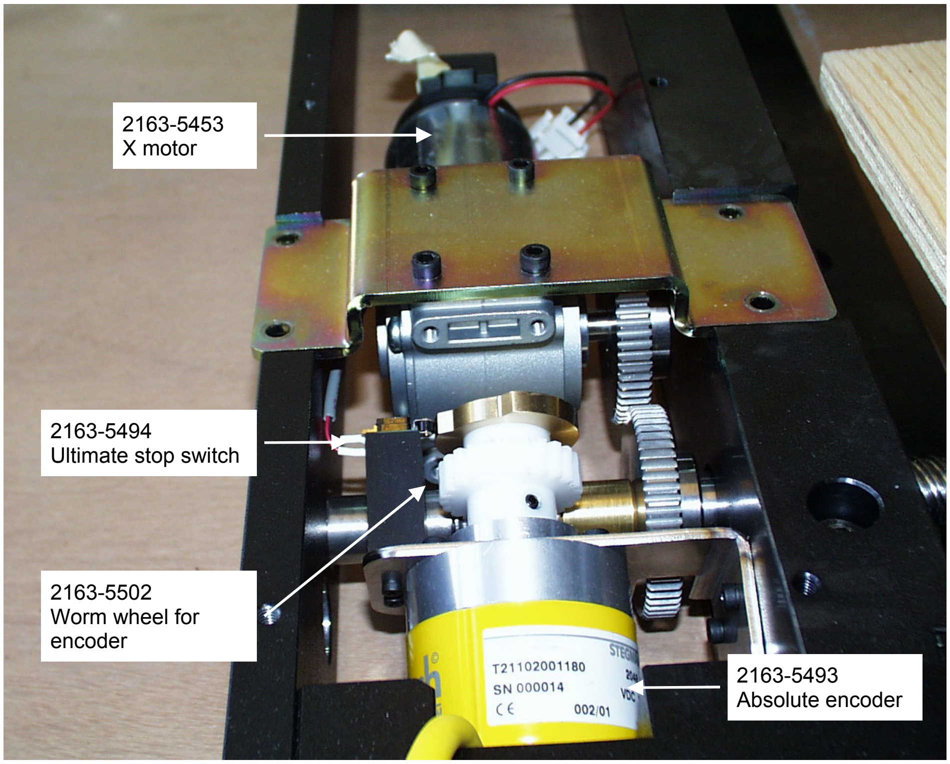


Figure 9.13 X-drive in gantry base

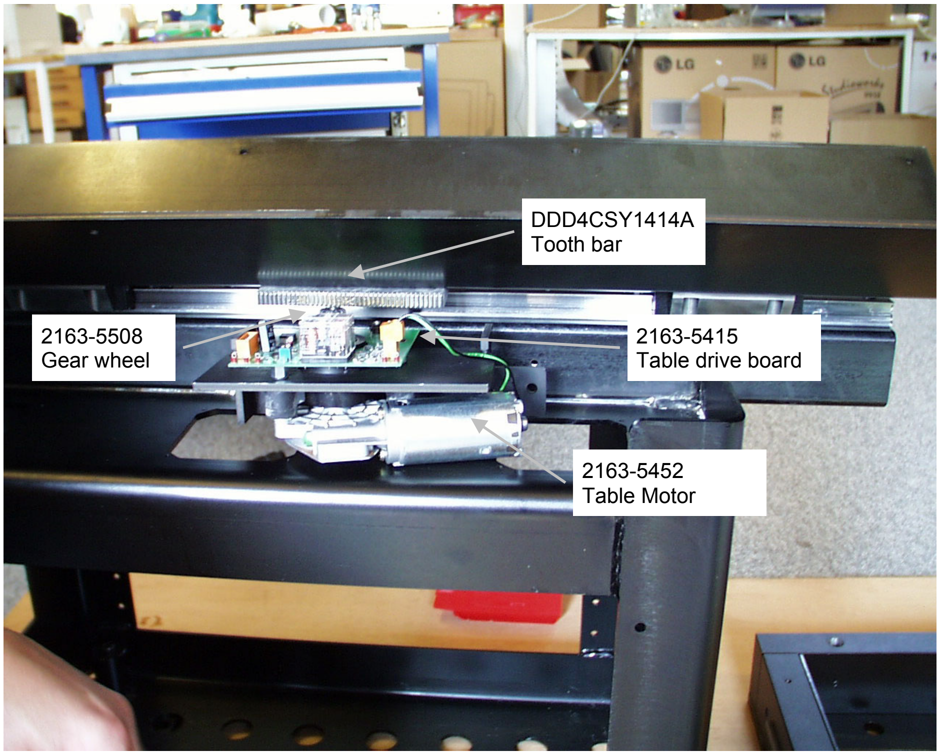


Figure 9.14 Table drive – rear of table console

I, II

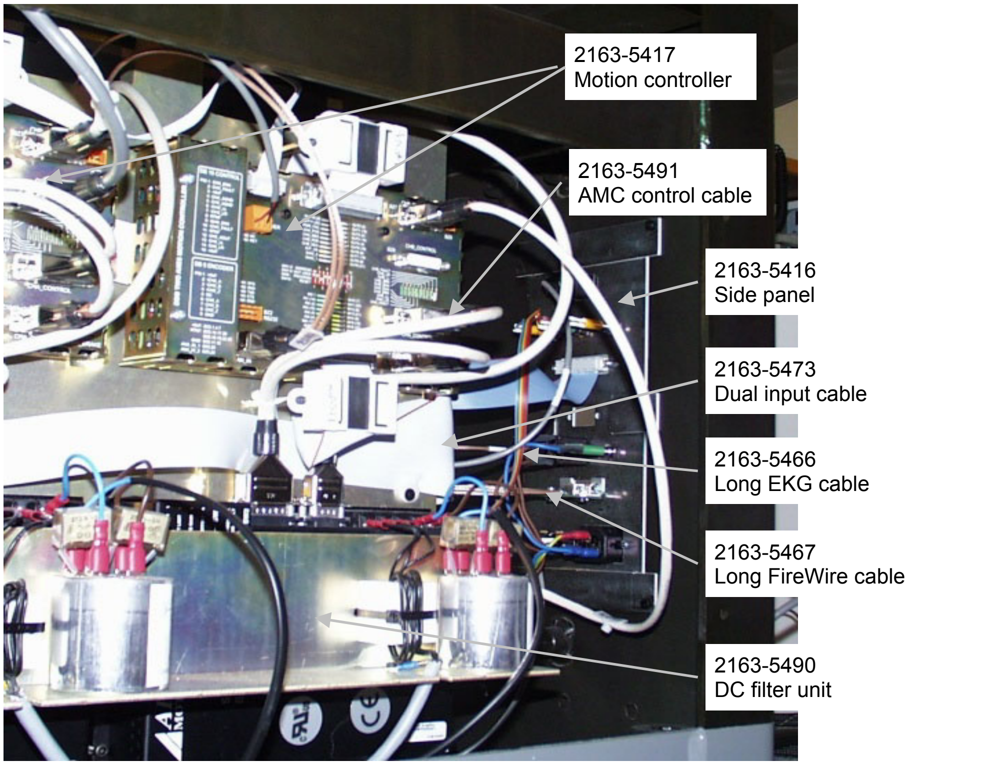


Figure 9.15 Table base – right front side (CardioMD Series I and II)

III

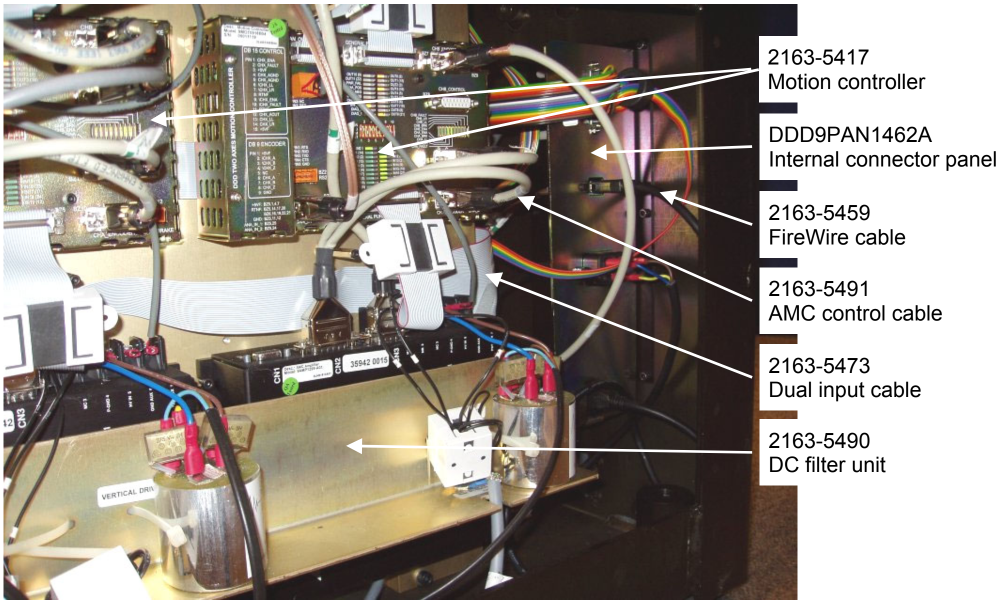


Figure 9.16 Table base – right front side (CardioMD Series III)

III

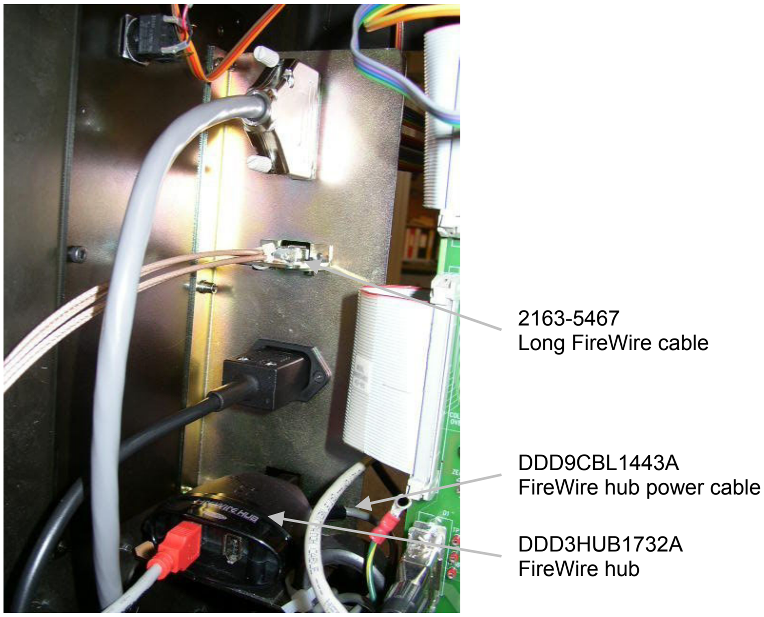


Figure 9.17 DDD9PAN1462A Internal connector panel seen from rear (CardioMD Series III)

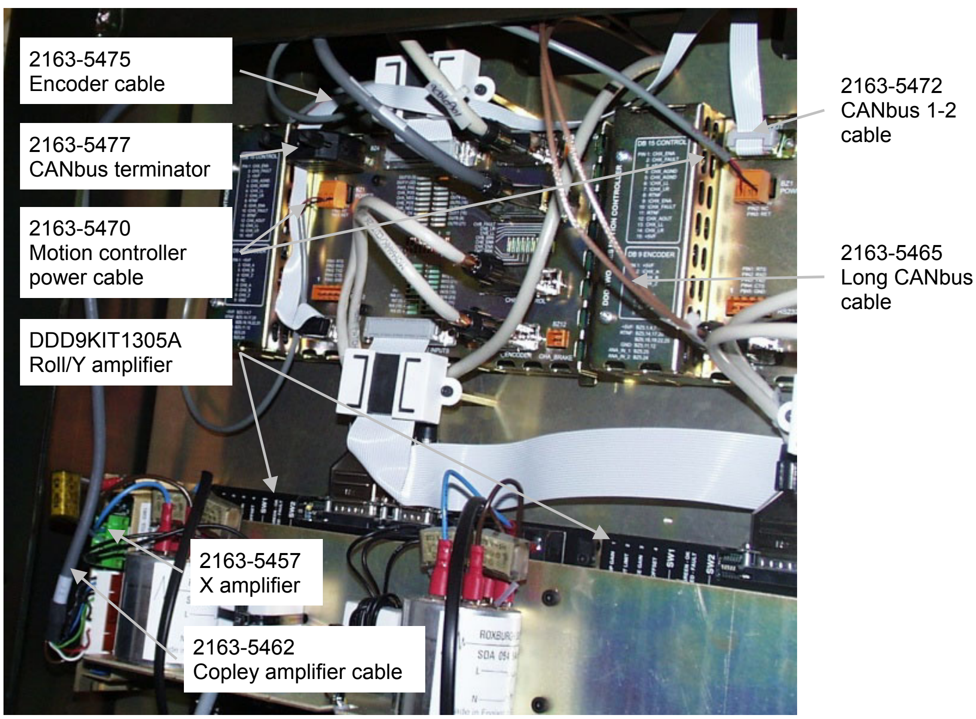


Figure 9.18 Table base – left front side

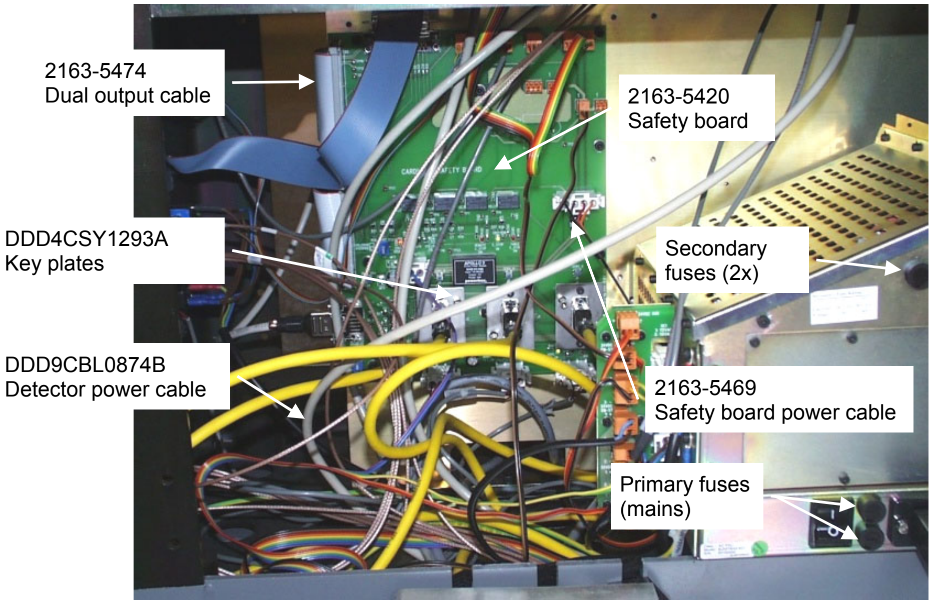
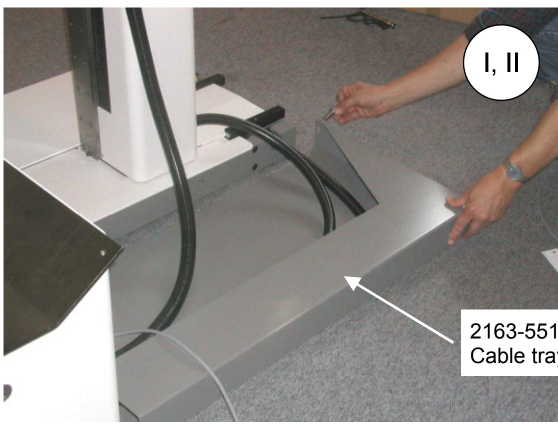


Figure 9.19 Table base – rear side



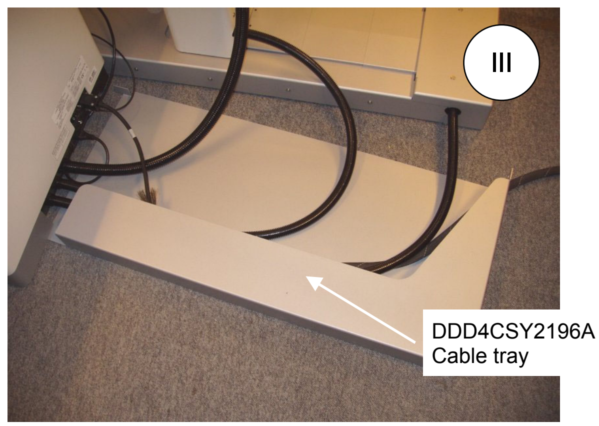


Figure 9.20 Cable tray

Fuses

The location of fuses is shown in Figure 9.19. Table 9.1 specifies the fuse ratings.

Fuses	*Parts #*	*Description*
6.25 A/250 V	2163-5499	Primary (mains) fuse when the power supply is set to 200 V, 220 V or 240 V AC mains voltage
12 A/250 V	2163-5500	Primary (mains) fuse when the power supply is set to 100 V or 120 V AC mains voltage
10 A/250 V	2163-5501	Secondary fuses

Table 9.1 CardioMD fuse ratings

9.2.3.2 Gantry Tower

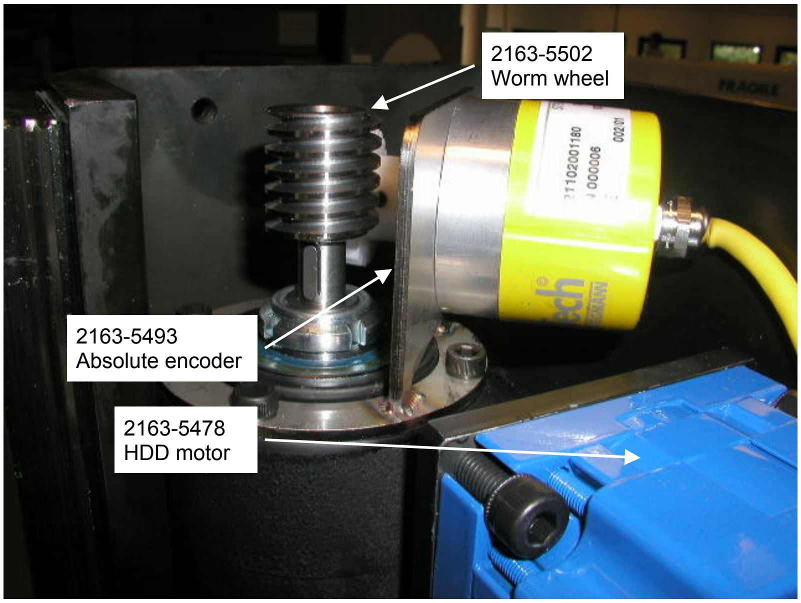


Figure 9.21 Y-drive in top of gantry tower

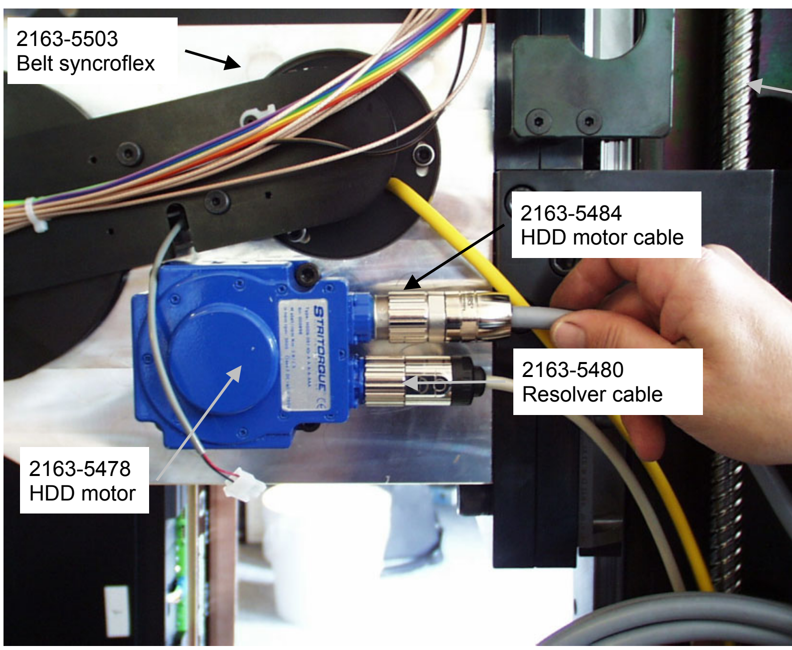


Figure 9.22 Roll drive on detector arm – reverse side from detector

9.2.3.3 Table End Support

I, II

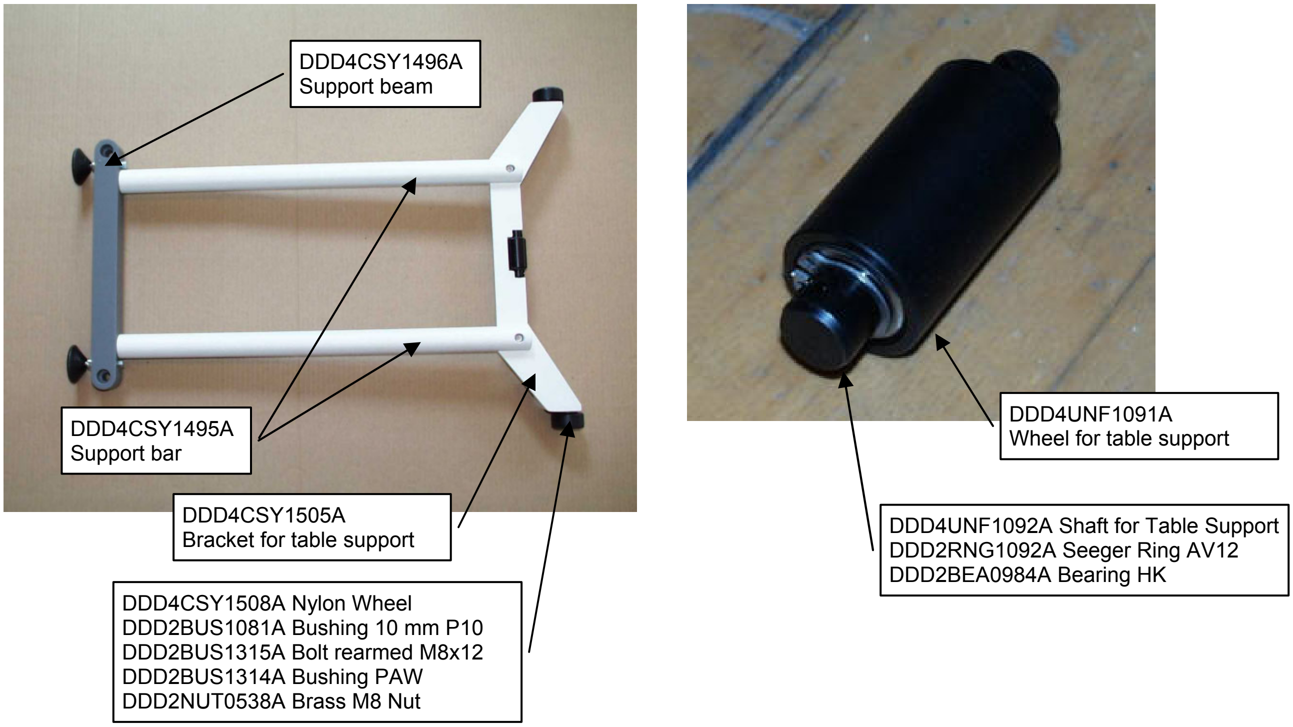


Figure 9.23 Table end support (Series I and II)

III

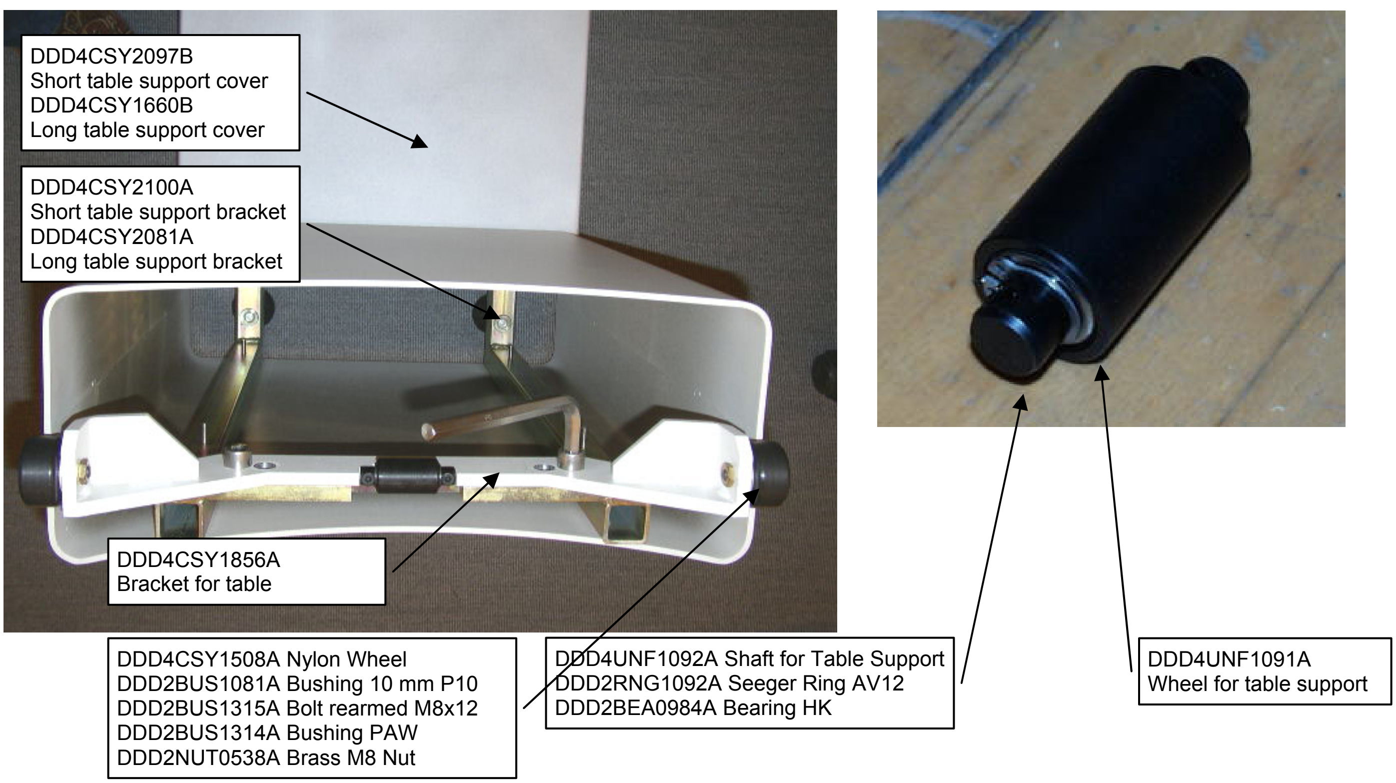


Figure 9.24 Table end support (Series III)

9.2.4 Acquisition PC

I, II

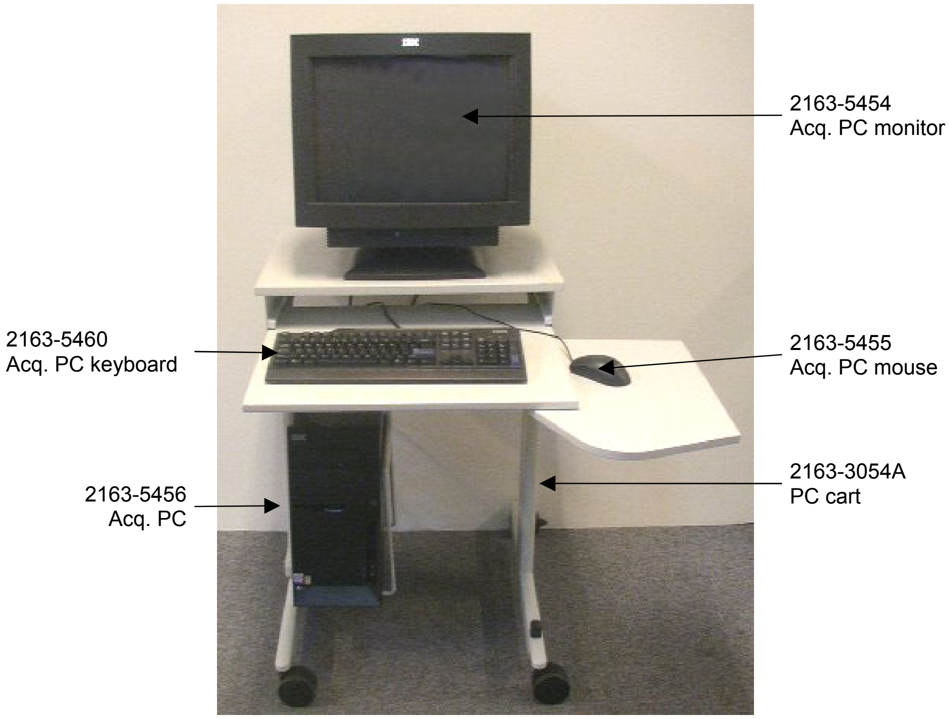


Figure 9.25 Tower acquisition PC (Series I and II)

I, II

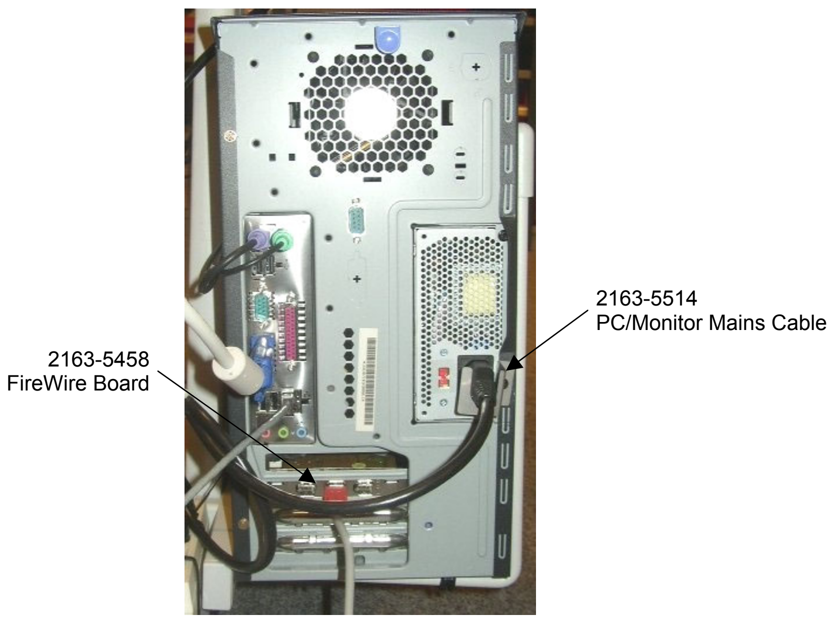


Figure 9.26 Tower acquisition PC – location of FireWire board (Series I and II)

III

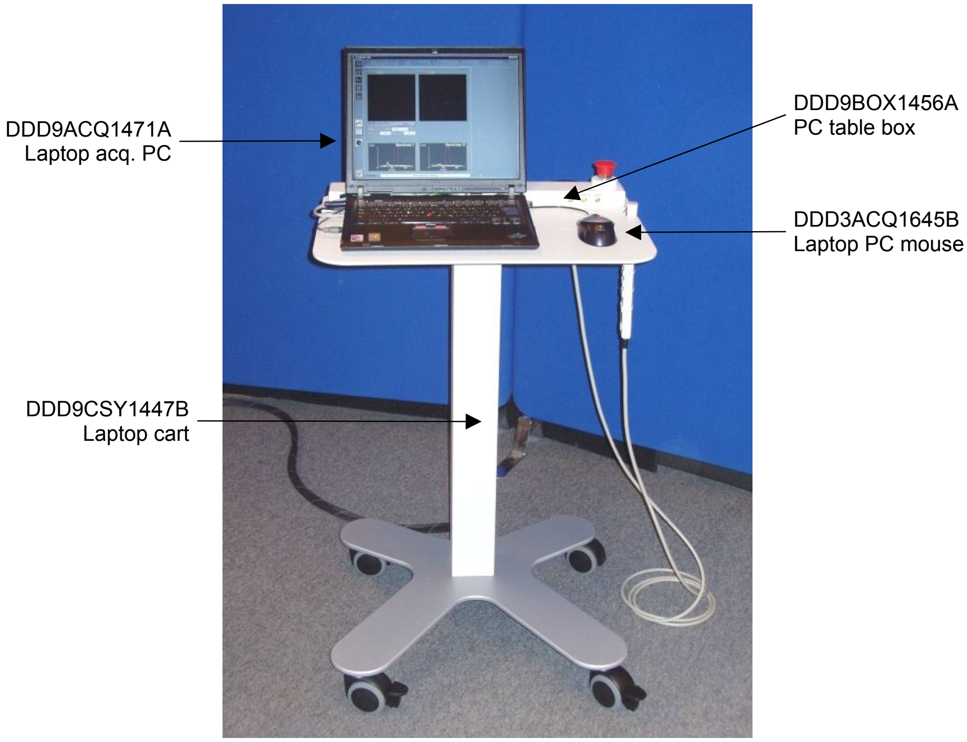


Figure 9.27 Laptop acquisition PC on laptop cart (CardioMD Series III)

III

Figure 9.28 Laptop acquisition PC on DDD9CSY1448A laptop wall mount (CardioMD Series III)

III

Figure 9.29 Laptop acquisition PC on DDD9CSY1449A desk mount (CardioMD Series III)

I, II

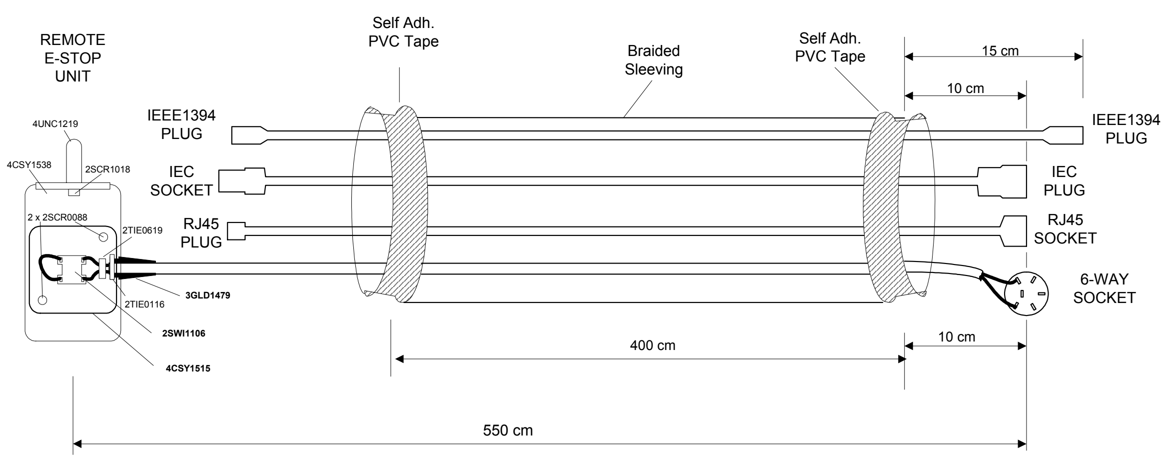


Figure 9.30 2163-5601 Cable between gantry and tower acquisition PC (CardioMD Series I and II)

III

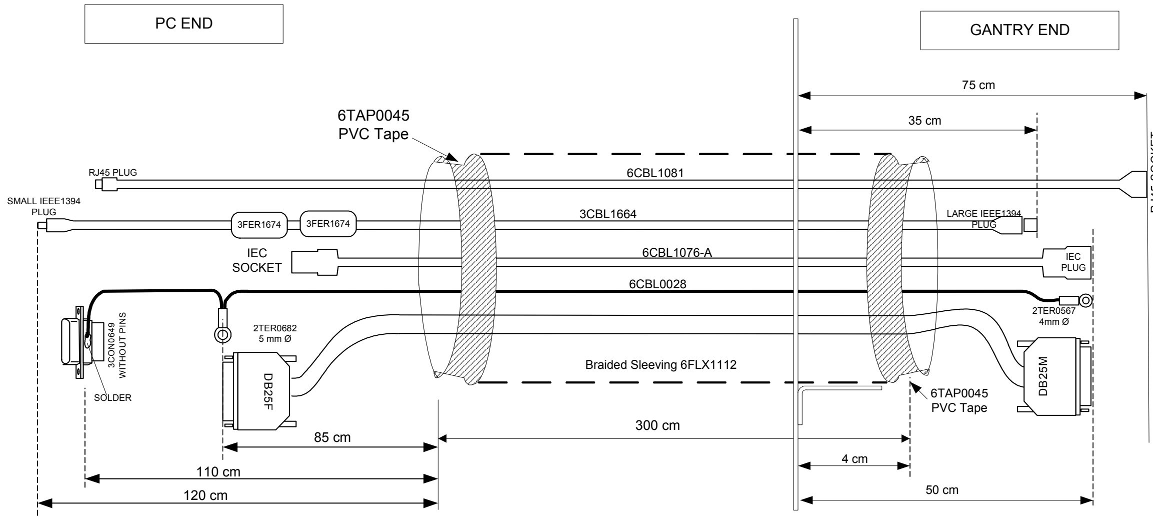


Figure 9.31 DDD9CBL1467A Cable (4.5 m) between gantry and laptop acquisition PC (CardioMD Series III)

III

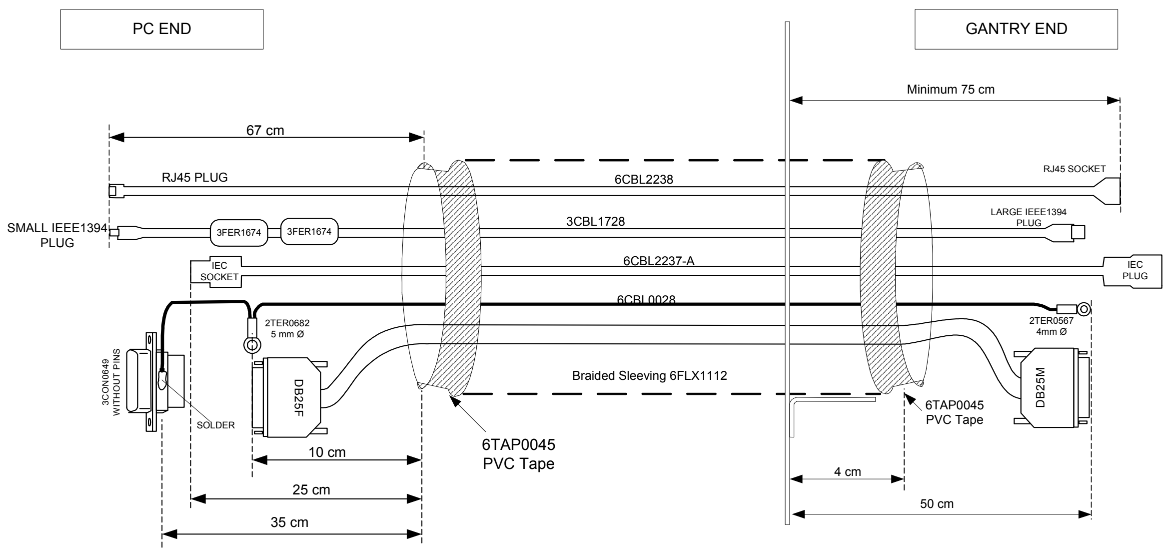


Figure 9.32 DDD9CBL1442A Cable (10 m) between gantry and laptop acquisition PC (Series III)

9.2.5 Accessories

System Series	*Accessory Part*	*Description of Part*
I, II	2163-5439 HEAD/SHOULDER SUPPORT	Device to be placed on the table top for patient comfort
III	DDD2CSY1909A HEAD/SHOULDER SUPPORT	
I, II, III	2163-5510 IV POLE	IV pole to be attached to the patient table, allowing an IV bottle to be placed conveniently close to the patient
I, II	2163-5435 QC KIT	The QC kit contains a brass point source holder that mounts onto a height adjustable tripod. A glass vial (in cluding a lid for the vial) is included and fits into the brass source holder. A FOV mask is also included in to kit
III	DDD9CSY0914B QC KIT	
I, II	2163-5519 FOV MASK	The FOV mask is part of the QC kit
III	DDD9CSY1381B FOV MASK	
I, II, III	2163-5497 VIAL 75x10 MM	This vial is included in the QC kit as a separate part
I, II, III	2163-5498 LID FOR VIAL 2163-5497	This lid is included in the QC kit as a separate part
I, II, III	2163-3050A BAR PHANTOM	Complete 4-field bar phantom option
I, II, III	2163-5461 ETHERNET CABLE	3 m twisted pair Ethernet cable for connecting the CardioMD system to the hospital network
I, II, III	2163-5602 POWER CABLE	Cable to apply mains to the CardioMD system
I, II, III	DDD3PLG1610A NEMA PLUG L5-20R	Power plug for CardioMD power cable
I, II	2163-5436 HAND CONTROLLER	Complete hand controller including cable connecting the hand controller to the CardioMD system
III	DDD9CSY1465A HAND CONTROLLER	
I, II, III	2163-3451 SHORT TABLE TOP	200 cm long curved aluminum table top
I, II	2163-3454 SHORT TABLE MATTRESS	Mattress for the 200 cm long table top
III	DDD4CSY2185A SHORT TABLE MATTRESS	
I, II, III	2163-3452 LONG TABLE TOP	280 cm long curved aluminum table top
I, II	2163-3453 LONG TABLE MATTRESS	Mattress for the 280 cm long table top
III	DDD4CSY2184A LONG TABLE MATTRESS	
I, II, III	DDD4CSY1542A COR SOURCE HOLDER	Source holder for COR calibration and COR check

9.2.6 Covers

I, II

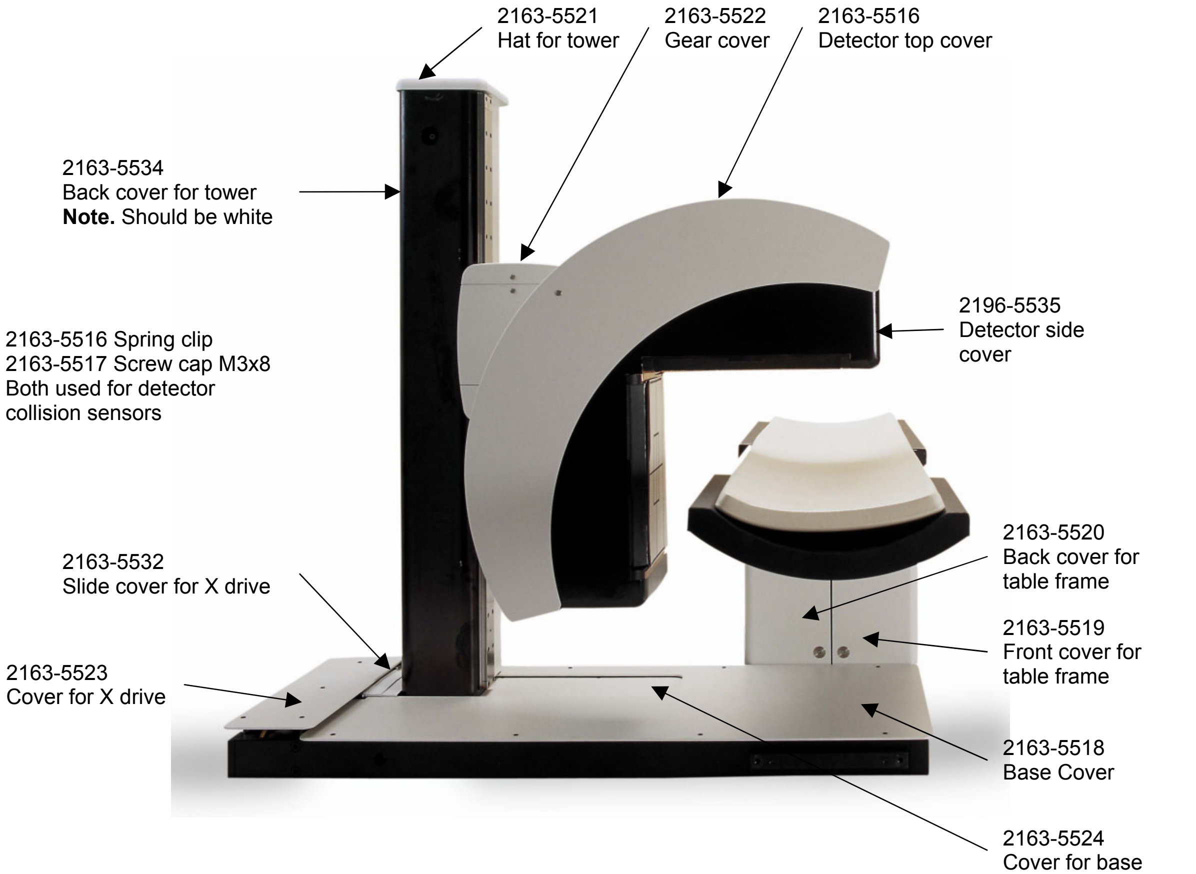


Figure 9.33 Location of covers (CardioMD Series I and II)

I, II

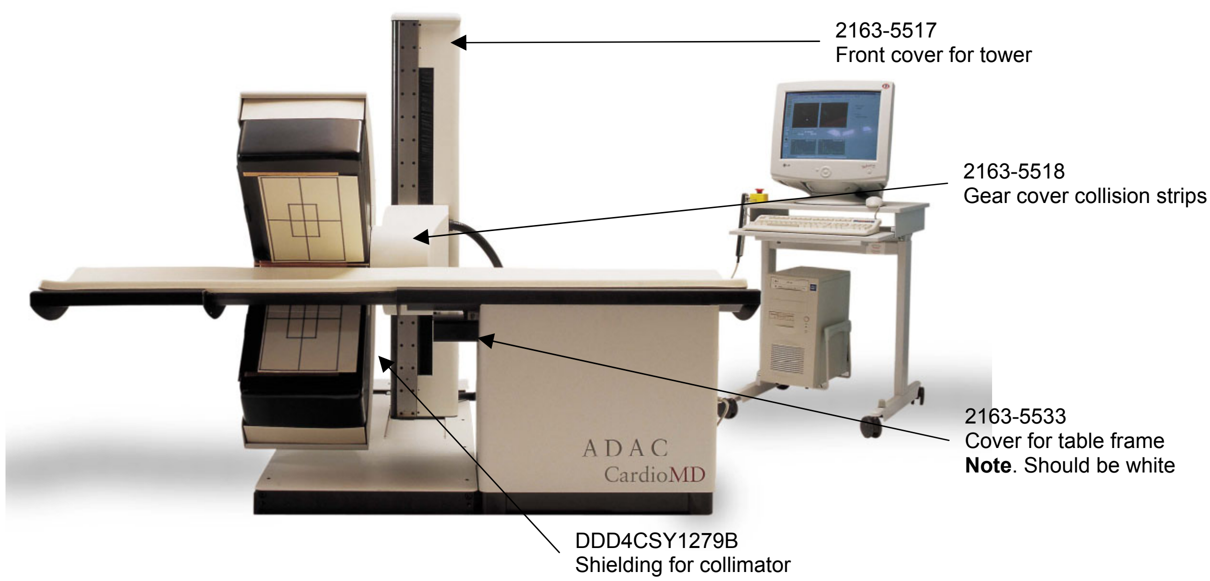


Figure 9.34 Location of covers (CardioMD Series I and II)

III

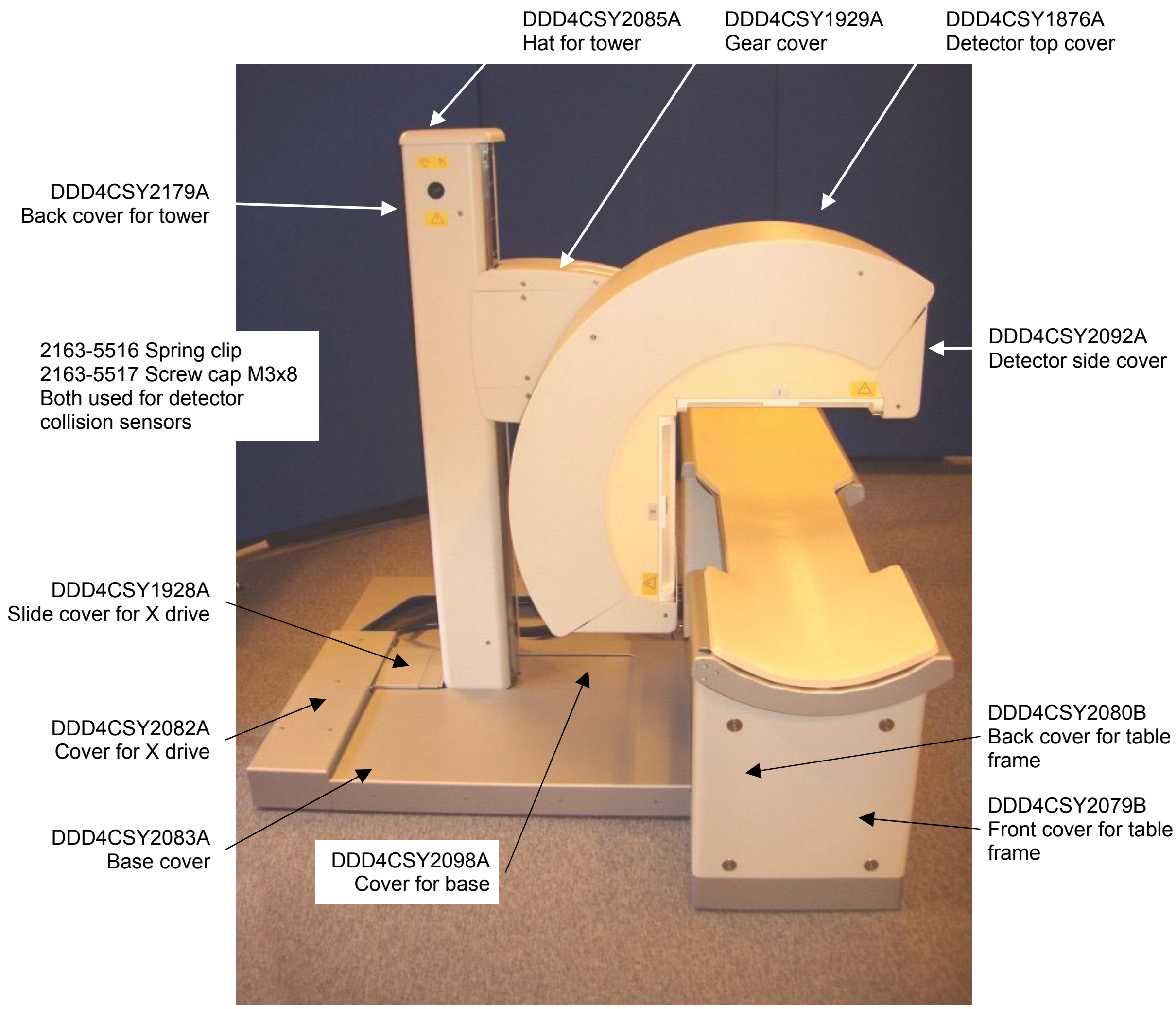


Figure 9.35 Location of covers (CardioMD Series III)

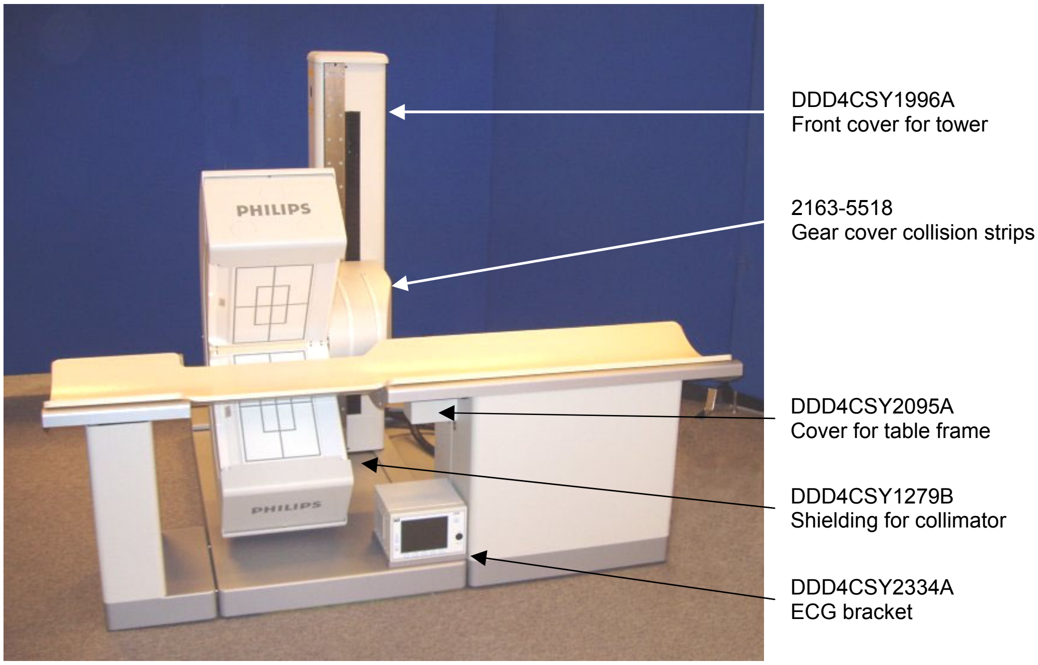


Figure 9.36 Location of covers (CardioMD Series III)

9.2.7 Service Tools

Figure 9.37 2163-5600 Motion controller RS232 cable

Figure 9.38 DDD3ACQ1669A USB-RS232 converter for laptop

9.2.7.1 Detector Service Kit

The 2163-5407 Detector service kit comprises all items shown.

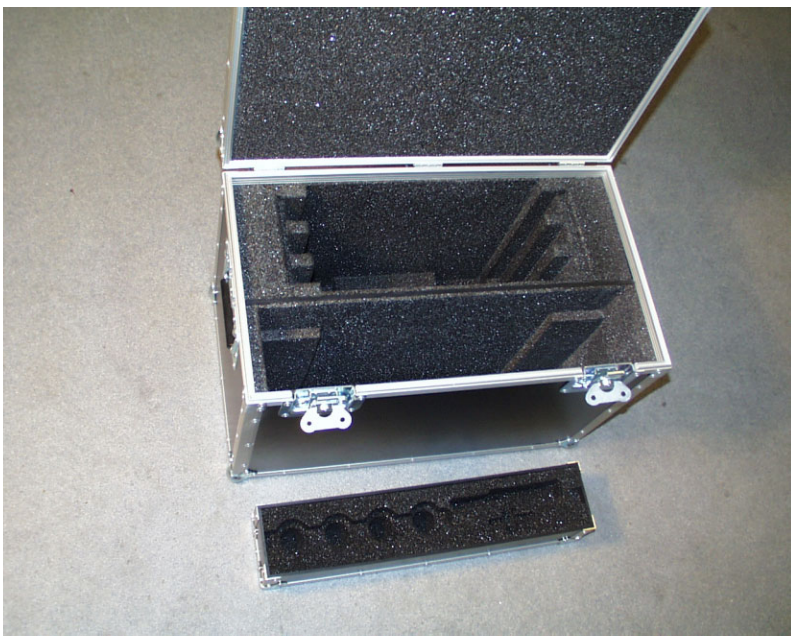


Figure 9.39 2163-5512 Shipping case

Figure 9.40 Source holders

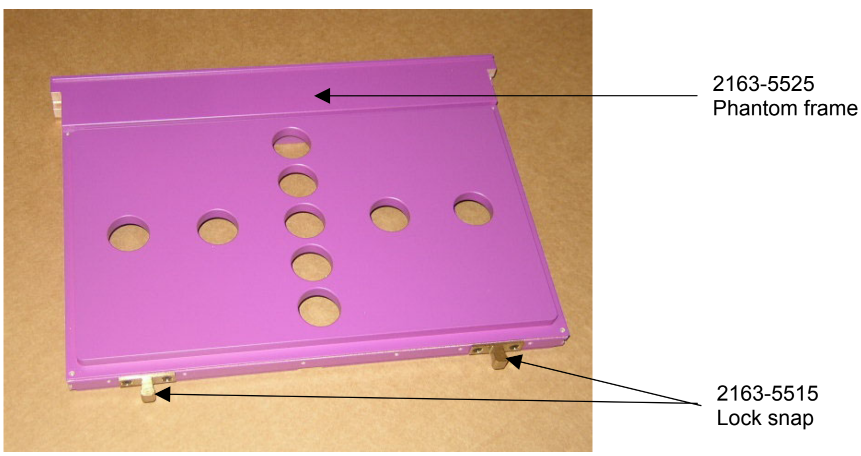


Figure 9.41 2163-5531 GeoCal mask

Figure 9.42 2163-5526 X-line phantom

Figure 9.43 2163-5529 Y-line phantom

9.2.7.2 NEMA Kit

The 2163-5408 NEMA kit comprises all items shown in this section.

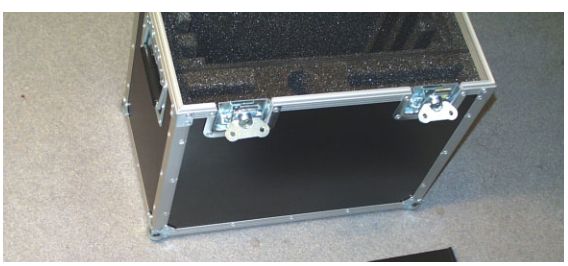


Figure 9.44 2163-5511 NEMA shipping case

Figure 9.45 2163-5530 NEMA mask

Figure 9.46 2163-5527 NEMA X-line phantom

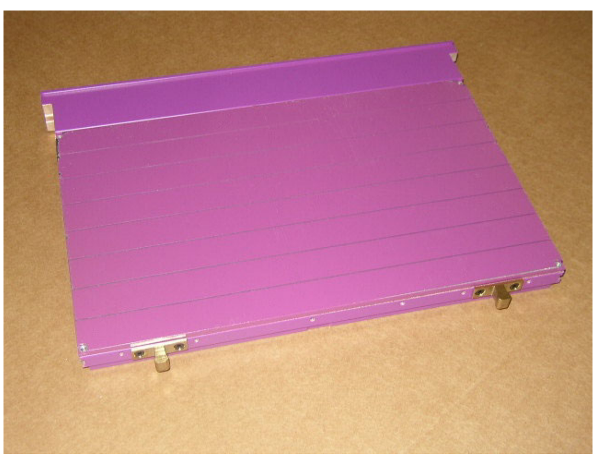


Figure 9.47 2163-5528 NEMA Y-line phantom

9.2.7.3 Miscellaneous Service Tools

Table 9.2 lists further service tools.

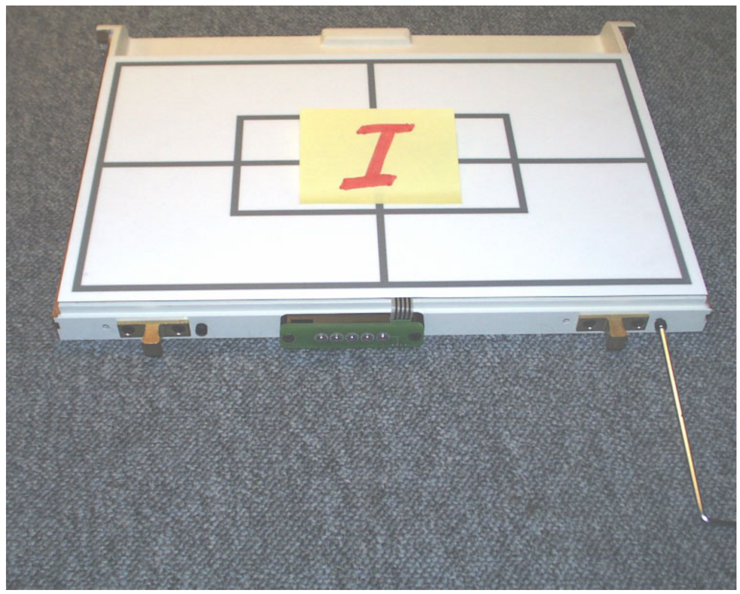
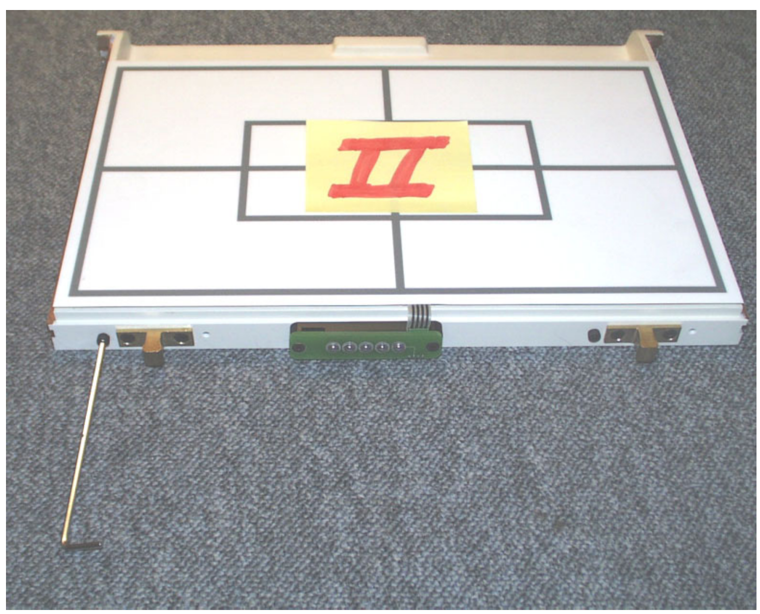
Philips part no.	*Part name*	*Description*
2163-5514	EXPANSION ANCHORS	Anchors for anchoring the CardioMD as part of installation
2163-5515	DOLLY ASSEMBLY	Complete Dolly system used for installation of the CardioMD
DDD4UNC1290A	DOLLY TRAPEZ	Trapez screw used to raise the system to mount and dismount the Dolly
DDD4CSY1278B	INSTALLATION TEMPLATE	Installation floor template for drilling and positioning
2163-3051A	SEISMIC INSTALLATION KIT	Kit to be used for installations in California.
DDD2GUM0760A	RUBBER SEALING	Rubber sealing to be applied between gantry and floor during installation
DDD2RUB1246A	CABLE PROTECTOR	Rubber cable protector to cover cables on the floor

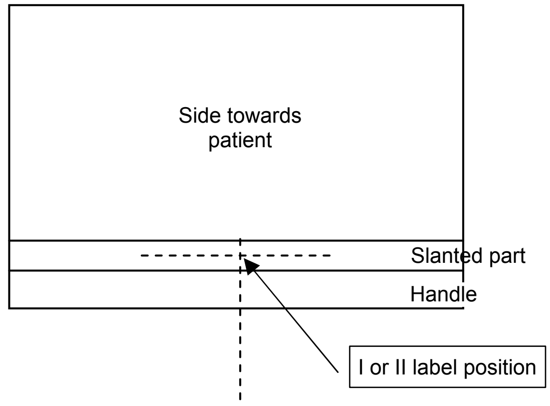
Table 9.2 Miscellaneous service tools

9.3 Installation Procedures

9.3.1 Collimators

Collimators for the CardioMD system are mechanically coded for detector 1 or detector 2. When receiving a spare collimator, you may have to change the mechanical coding of the collimator to fit it onto the detector.The procedure describes the steps involved when replacing a collimator.

Procedure	***Details***
1. Determine if the collimator is to be coded for detector 1 or detector 2.	
2. If the collimator is to be coded for detector 1, place the two M4x6 screws to the right of the collimator locks, as shown in the photo on the right.	
3. To code the collimator for detector 2, place the two M4x6 screws to the left of the collimator locks, as shown in the photo on the right.	

Procedure	*Details*
4. Attach the collimator number label (I or II) onto the collimator in the location indicated in the diagram on the right.	
5. After replacing a collimator, you must acquire: - A new center of rotation correction table - New extrinsic uniformity calibration tables.	
Refer to the Operator's Manual Chapter 5 *Maintenance* for procedures for performing center of rotation calibration and extrinsic uniformity calibration.	

10 NEMA Performance Measurement

Contents

10.1 Introduction

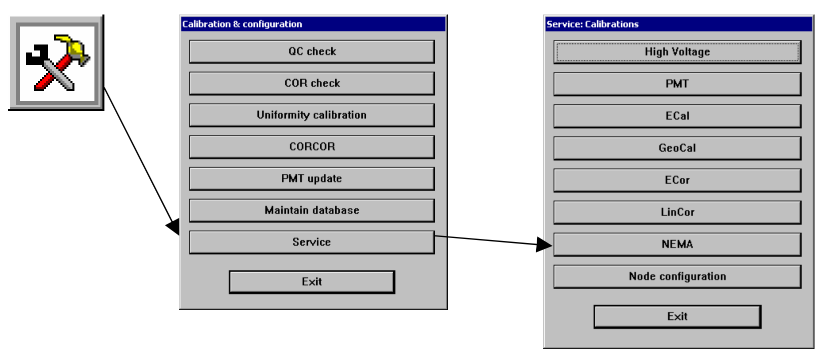
This section of the CardioMD service manual describes procedures for performing NEMA performance measurements on the CardioMD detectors.

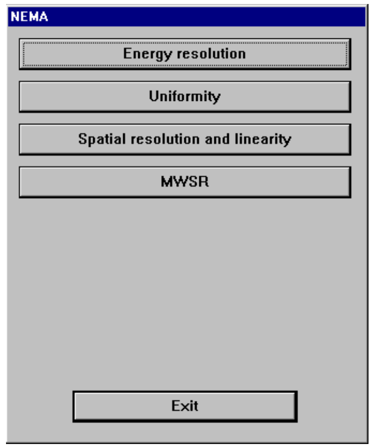
The acquisition PC includes dedicated software to perform these NEMA measurements. To access any NEMA tests, follow instructions below.

Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed before NEMA testing can be performed. See Chapter 12 *CardioMD AC Option* for instructions.

Note. The detectors must be uncollimated for all NEMA performance measurements.

Note. Make sure that the system is in the patient load position before accepting any automatic motions to bring the detectors into position for NEMA measurements.

Procedure	***Details***
1. If the CardioMD system is equipped with the AC Option, remove the transmission scanners before performing NEMA tests. See Chapter 12 *CardioMD AC Option* for instructions.	
2. Make sure that the system is in patient load position before entering any NEMA procedure. Automated motion bringing the detectors into position for the NEMA measurements may fail if not executed from patient load position.	
3. On the Persistence page, click the Tools button. 4. When the Calibration & Configuration menu appears, click Service. 5. If prompted, enter the service password (see Chapter 4 *Calibration* for instructions). 6. In the Service Calibrations menu, click NEMA.	

Procedure	***Details***
The NEMA menu appears. This menu gives access to four tests, which are described in the following.	

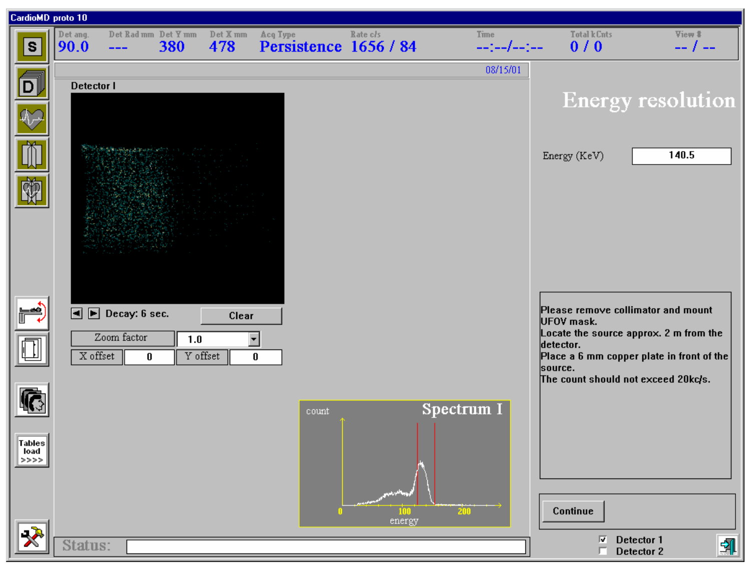
10.2 NEMA Energy Resolution

10.2.1 Test Requirements

Detector:	Intrinsic, no collimator. One detector at a time.
Source:	Tc-99m ~ 7–20 MBq or 200–500 µCi, yielding 20 kcps or less Co-57 ~ 7–20 MBq or 200–500 µCi, yielding 20 kcps or less.
Phantom:	NEMA Mask.
Source holder:	Point source holder.
Total test time:	Approximately 2 times 5 minutes per detector.

10.2.2 Test Procedure

Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed before the NEMA Energy Resolution test can be performed. See Chapter 12 *CardioMD AC Option* for instructions.

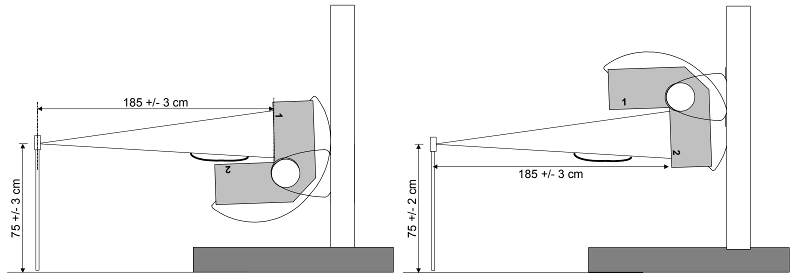
Procedure	***Details***
1. In the NEMA menu, select Energy resolution. The Energy resolution page appears. 2. In the Energy field, enter 140.5 for Tc-99m. (The default setting is 140.5 keV.) 3. Check Detector 1 or Detector 2 to specify the detector to be measured. 4. Click Continue. 5. Click OK to accept automated motions. Automated motions will now position the selected detector for measuring energy resolution.	

Note. Automated motions must be started from the patient load position.

Procedure	***Details***
6. Replace the collimator on the selected detector with the NEMA mask (slide the collimator out and slide in the mask).	

Procedure | ***Details***

7. Place the point source holder at a minimum distance of approximately 1.85 meters from the detector.
8. Place a ~ 200–500 μCi (7–20MBq) Tc-99m point source yielding 20 kcps or less in the holder.

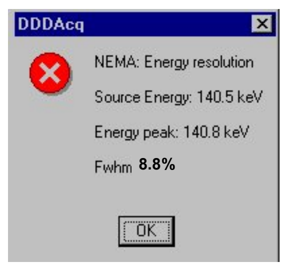


Note. Make sure that the position of the source holder is aligned with the center of the detector FOV. It is important that the entire detector FOV is exposed to the source.

Procedure | ***Details***

9. Make sure that the entire detector FOV is exposed to the source and that the count rate is < 20 kcps.
10. Click Start.

When the test is complete, the result is shown in a pop-up window.



11. Note both the Fwhm and the Energy peak result. Click OK to remove the pop-up.

The energy resolution specification is ≤ 9.4%.

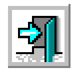
12. Remove the Tc-99m source and place a ~ 200–500 μCi (7–20MBq) Co-57 point source yielding 20 kcps or less in the holder.
13. On the Energy resolution page, enter 122.1 in the Energy field for Co-57.
14. Click Start.

When the test is complete, the result is shown in a pop-up window.

15. Note the Fwhm and the Energy peak result. Click OK to remove the pop-up.

Now calculate the NEMA Energy resolution result:

16. Subtract the Energy peak result for Co-57 from the Energy peak result for Tc-99m. Divide the result by 18.4 to get a correction figure.
17. Divide the Fwhm result for Tc-99m by the correction figure to get the true NEMA re-

Procedure	***Details***
sult.	
18. Replace the NEMA Mask with the collimator.	
19. Click Exit to return to the NEMA menu.	

Note. To measure the other detector, place the CardioMD system in the patient load position before repeating the procedure outlined above.

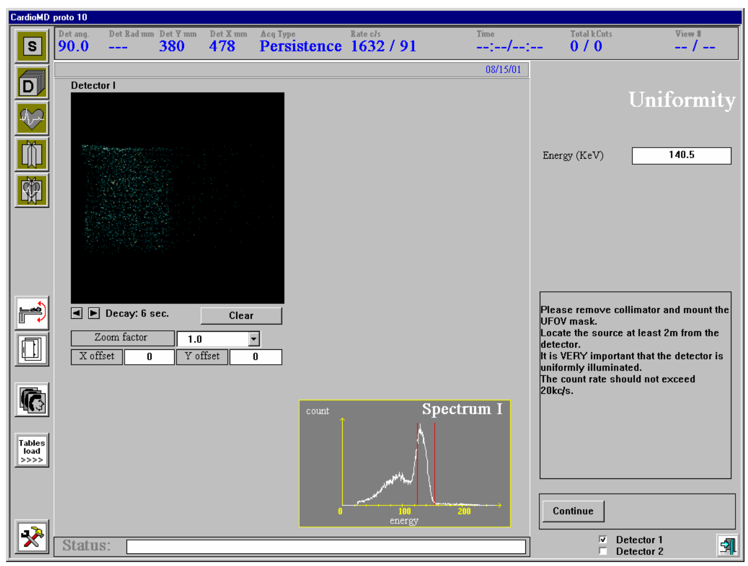
10.3 NEMA Uniformity

10.3.1 Test Requirements

Detector:	Intrinsic no collimator. One detector at a time.
Source:	Tc-99m ~ 7–20 MBq or 200–500 µCi point source, yielding 20 kcps or less.
Source holder:	Point source holder.
Mask:	FOV mask (part no. 2163-5519) **Note**. The mask used for the NEMA uniformity test is *not* the NEMA mask.
Total test time:	Approximately 45 minutes per detector.

10.3.2 Test Procedure

Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed before the NEMA Uniformity test can be performed. See Chapter 12 *CardioMD AC Option* for instructions.

Procedure	***Details***
1. In the NEMA menu, select Uniformity. The Uniformity page appears. 2. In the Energy field, enter 140.5 for Tc-99m. 3. Check Detector 1 or Detector 2 to specify the detector to be measured. 4. Click Continue. 5. Click OK to accept automated motions. Automated motions will now position the selected detector for measuring uniformity.	

Note. Automated motions must be started from the patient load position.

Note. The detector positions used are the same as the ones used for energy resolution measuring. See page 10-5.

Procedure	***Details***
6. Replace the collimator on the selected detector with the FOV Mask – *not* the NEMA mask (slide the collimator out and slide in the mask).	

Note. Be sure to use the FOV mask for this test, *not* the NEMA mask.

Procedure	***Details***
7. Remove the collimator from the detector *not* in use to avoid the "U.diff.140.1 not found" error message	
8. Place the point source holder at a minimum distance of 2 meters (6 ft.) from the detector.	
9. Place a ~ 200–500 µCi (7–20 MBq) Tc-99m point source yielding 20 kcps or less in the holder.	

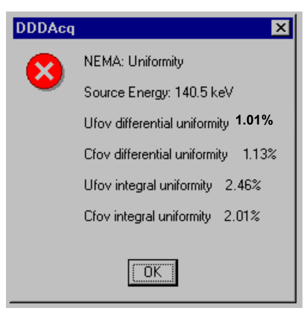
Note. Make sure that the position of the source is exactly in front of the center of the detector FOV. It is very important that the entire detector FOV is *uniformly* exposed to the source.

Procedure ***Details***

10. Make sure that the entire detector FOV is exposed to the source and that the count rate is < 20 kcps.

11. Click Start.

When the test is complete, the result is shown in a pop-up window.



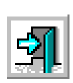
12. Note the result. Click OK to remove the pop-up.

Uniformity specifications are:

UFOV differential	≤	1.5%
CFOV differential	≤	1.5%
UFOV integral	≤	2.5%
CFOV integral	≤	2.5%.

13. Replace the FOV Mask with the collimator.

14. Click Exit to return to the NEMA menu.



Note. To measure the other detector, place the CardioMD system in the patient load position before repeating the procedure outlined above.

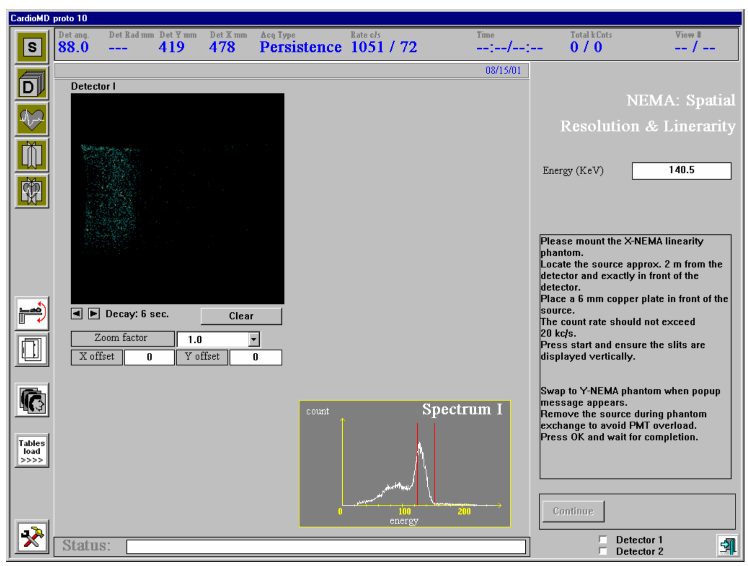
10.4 NEMA Spatial Resolution and Linearity

10.4.1 Test Requirements

Detector:	Phantoms. One detector at a time.
Source:	Tc-99m ~ 150–200 MBq or 4–5 mCi point source yielding 20 kcps or less.
Source holder:	Point source holder.
Phantoms:	NEMA X and Y Line Phantoms.
Total test time:	Approximately 2 times 15 minutes per detector.

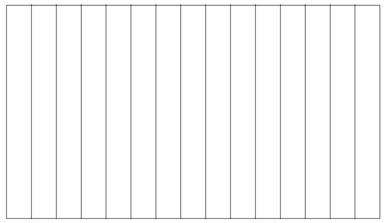
10.4.2 Test Procedure

Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed before the NEMA Spatial Resolution test can be performed. See Chapter 12 *CardioMD AC Option* for instructions.

Procedure	***Details***
1. In the NEMA menu, select Spatial resolution and linearity.	
The Spatial Resolution and Linearity page appears.	
2. In the Energy field, enter 140.5 for Tc-99m.	
3. Check Detector 1 or Detector 2 to specify the detector to be measured.	
4. Click Continue.	
5. Click OK to accept automated motions.	
Automated motions will now position the selected detector for measuring spatial resolution and linearity.	

Note. Automated motions must be started from the patient load position.

Note. The detector positions are the same as the ones used to measure energy resolution. See page 10-5.

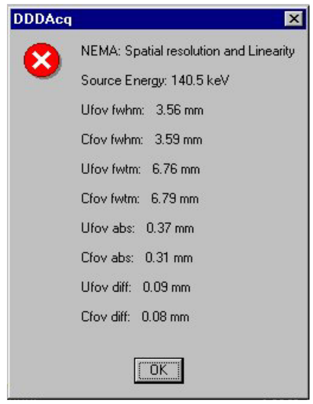
Procedure	***Details***
6. Replace the collimator on the selected detector with the NEMA X line phantom (slide the collimator out and slide in the phantom). The X phantom has slits in the short direction.	
7. Place the point source holder at a minimum distance of 2 meters from the detector.	
8. Place a ~ 4–5 mCi (150–200 MBq) Tc-99m point source yielding 20 kcps or less in the holder.	

Note. Make sure that the position of the source holder is aligned with the center of the detector FOV.

Procedure	***Details***
9. Make sure that the entire detector FOV is exposed to the source and that the count rate is < 20 kcps.	
10. Check that the phantom slits are seen as vertical lines	
11. Click Start.	
When the test is complete, the pop-up shown to the right appears. **Note**. Do *not* click OK yet. Mount the Y slit phantom first.	
12. Replace the NEMA X line phantom with the Y line phantom. The Y phantom has slits in the long direction. 13. Click OK.	

Procedure	***Details***

When both the X and Y measurements have been completed, a pop-up similar to the one shown on the right appears.



14. Note the results and click OK to close the pop-up.

Resolution specifications are:

UFOV FWHM	≤	3.7 mm
CFOV FWHM	≤	3.7 mm
UFOV FWTM	≤	7.6 mm
CFOV FWTM	≤	7.6 mm

Linearity specifications are:

UFOV absolute	≤	0.5 mm
CFOV absolute	≤	0.5 mm
UFOV differential	≤	0.2 mm
CFOV differential	≤	0.2 mm.

15. Replace the NEMA Y line phantom with the collimator.

16. Click Exit to return to the NEMA menu.

Note. To measure the other detector, place the CardioMD system in the patient load position before repeating the procedure outlined above.

10.5 NEMA Multiple Window Spatial Registration (MWSR)

10.5.1 Test Requirements

Detector:	Phantoms. One detector at a time.
Source:	4 sources, Ba-133, Ga-67 or Tl-201 ~ 7–20 MBq or 200–500 µCi, yielding a total of 20 kcps or less.
Source holder:	4 point holders for the GEOCAL mask.
Phantoms:	GEOCAL mask
Total test time:	Approximately 10 minutes per detector.

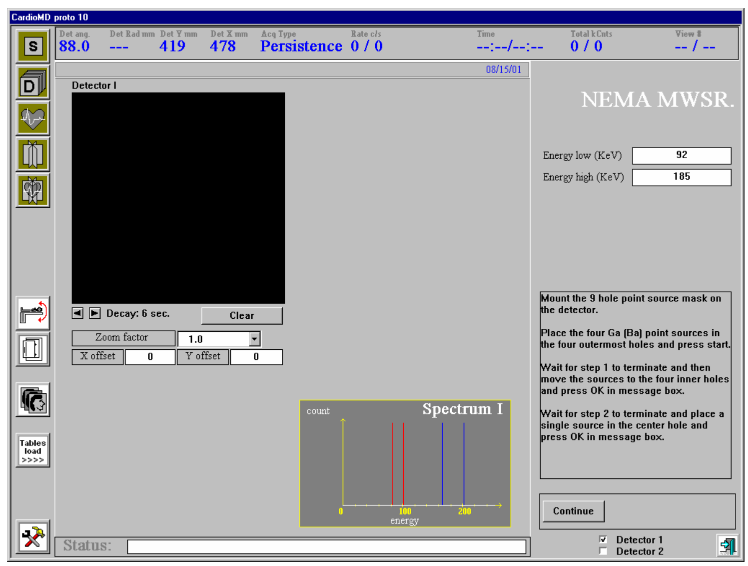
10.5.2 Test Procedure

Note. If the CardioMD system is equipped with the AC Option, the transmission scanners must be removed before the NEMA MWSR test can be performed. See Chapter 12 *CardioMD AC Option* for instructions.

Procedure	*Details*

1. In the NEMA menu, select MWSR.

The MWSR page appears.



2. Enter isotope energies as follows:

   For Ba enter:
   81 in the Energy low field.
   155 in the Energy high field.

   For Ga enter:
   92 in the Energy low field
   185 in the Energy high field.

   For Tl enter:
   72 in the Energy low field
   167 in the Energy high field.

3. Click Continue.
4. Click OK to accept automated motions.

Automated motions will now position the detectors for measuring MWSR.

Note. Automated motions must be started from patient load position.

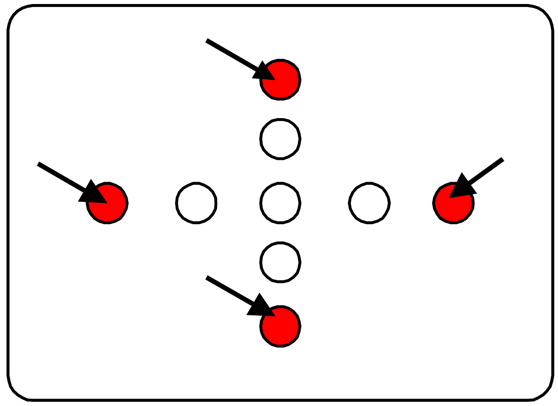
Note. The position used for MWSR measurement is the same for both detectors. In this position the detectors are raised above the patient table and rotated to +135°.

Procedure	***Details***

5. Replace the collimator on the selected detector with the GEOCAL mask.
6. Fill the four vials and place them in the 4 lead pigs.

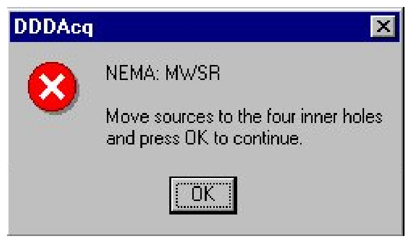
Note. The vials must be half full.

7. Place the four lead pigs in the outer four holes in the GEOCAL Mask.
8. Check that all four sources are visible and that the count rate is < 20 kcps.
9. Click Start.

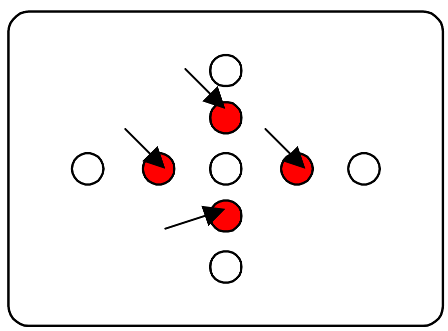


10. After 400 kilocounts, this pop-up message appears.

Note. Do not click OK at this point. Move the four sources first.

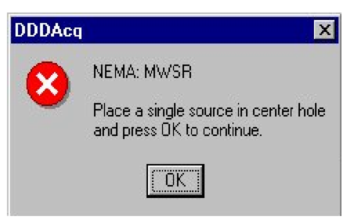


11. Move the four sources to the four inner holes.
12. Click OK to acquire the next 400 kilo-counts.

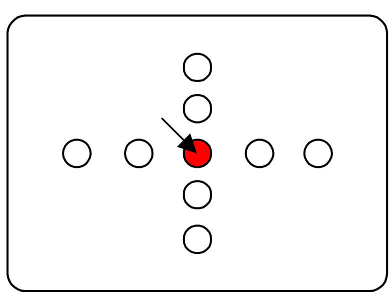


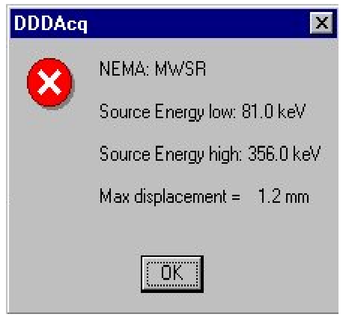
After the second 400 kilocounts, this pop-up message appears.

Note. Do not click OK at this point. Move the four sources first.



13. Remove the four sources.
14. Place one of the sources in the center of the GEOCAL mask.
15. Click OK to acquire the last 400 kilo-counts.



Procedure	***Details***
After the last 400 kilocounts the result pops up. 16. Note the result. The MWSR specification is ≤ 2.0 mm.	
17. Remove the GEOCAL mask and the remaining lead pig from the detector and mount the collimator.	
18. Click Exit to return to the NEMA menu.	

Note. To measure the other detector, place the CardioMD system in the patient load position before repeating the procedure outlined above.

11 PLANNED MAINTENANCE

Contents

11.1 Introduction

The CardioMD is designed for intensive use over many years. Mechanically it is robust and it has wide margins electrically. However, to ensure continuous performance, some periodic maintenance is required.

Most of the recommended maintenance has been simplified to the extent that users can undertake it themselves. Chapter 5 *Maintenance* of the Operator's Manual describes user maintenance requirements such as cleaning, check of image quality, simple detector calibrations and checks of safety devices.

This section addresses planned maintenance that should be performed by service personnel. Some of it is also listed in the Operator's Manual for the user to perform on daily and weekly basis. However, service personnel should make sure that these procedures have been followed and if not, include them on the periodic visits.

CAUTION

Caution. The CardioMD performs motorized motions and represents a risk for personal injury. It is therefore strongly recommended to carry out periodical checks of the safety systems. This is already emphasized in the Operator's Manual, but should also be a part of a periodic maintenance plan, carried out by qualified service personnel.

11.2 Planned Maintenance Schedule

Frequency	***Tasks***
1 month after installation	Verify that the user is acquainted with the daily/weekly checks described in the Operator's Manual. Verify that the daily/weekly checks have been performed. Check collision sensors and E-stop. Inspect the image quality, and recalibrate if necessary.
Every 6 months	Verify that the user is acquainted with the daily/weekly checks described in the Operator's Manual. Verify that the daily/weekly checks have been performed. Check collision sensors and E-stop. Inspect the image quality, and recalibrate if necessary. Check motion limits. Grease moving parts. Verify that the system ground continuity is intact and in a condition that can conduct a current equal to 25 A without breaking down. Ref to IEC 60601-1, section 18 *Protective Earthing* and section 19.2 *Single Fault Conditions*. Delete old log files. If the CardioMD AC Option is installed on the system, grease the acme screw inside the line source compartment. See Chapter 12 *CardioMD AC Option* for instructions.

11.3 Planned Maintenance Procedures

11.3.1 Inspection Check List from the Operator's Manual

Item	*Inspection*	*Frequency*
Cables	Check cables connected to the PC and monitor. Check for damage to insulation especially around cable clamps	Weekly
	Check that all external cables are secured in connector clamps where applicable	Weekly
Panels	Check the security and condition of all external panels on gantry and PC	Weekly
Collima-tors	Check all collimators for damage to septa and to locking mechanism	Weekly
Uniform-ity	Check the uniformity of the detectors by an intrinsic or extrinsic QC check	Daily
COR	Check the center of rotation for all collimators	Weekly
Collision sensors	Check the functionality of all collimator, detector and gearbox collision sensors	Daily
Hand con-troller	Check the hand controller for cracks and damage. Check the connection points on the hand controller and on the gantry	Daily
Table	Check the table pallet and mattress for damage	Daily
E-Stop	Check both E-Stop buttons for correct operation. When an E-Stop button is activated, no gantry motions should be possible, the yellow E-Stop indicator should be on and the green motor power indicator should be off	Daily

11.3.2 Inspection of Image Quality

As uniformity correction is applied in normal use and in QC uniformity checks, there is a risk that severe image imperfection has been covered by uniformity correction updated by the user. Therefore a flood image should be acquired without uniformity correction applied.

For each detector, acquire an intrinsic 3 million count static image with uniformity set to None, using a Tc-99m or Co-57 point source. Some faint lines and shadows along the edges are acceptable, but there must not be pronounced tube patterns, holes or bands in the image.

11.3.3 Check of Motion Limits

With the hand controller, move the detector as far as it will go in all directions (vertical, horizontal and rotate). During these checks, position the detector to avoid conflicts with the patient table.

- Verify that the vertical motion axis does not enter into any of the ultimate limits.
- Verify that the horizontal motion axis does not enter into any of the ultimate limits.

- Verify that the rotational motion axis does not enter into any of the ultimate limits.

If an ultimate limit is reached, refer to Chapter 4 *Calibration* for procedures for calibration of absolute encoders and ultimate limits.

Also verify that the detectors are automatically stopped before hitting the patient table when driving the detectors vertically and horizontally towards the patient table.

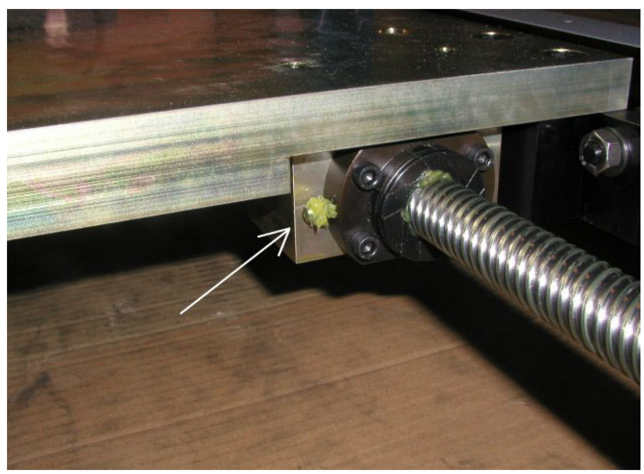
If it is possible to drive the detectors into the patient table, refer to Chapter 4 *Calibration* for procedures to calibrate the absolute position encoders.

11.3.4 Lubrication

11.3.4.1 Tools Required

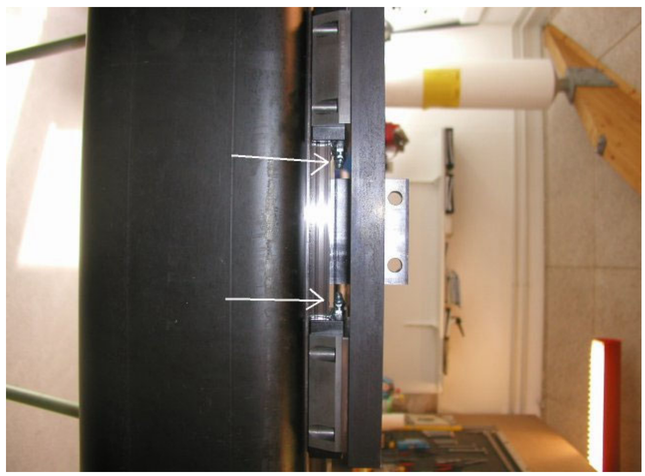
- Grease gun with lithium-based grease.

11.3.4.2 Horizontal Drive

Procedure	*Details*
1. Remove the cover from the gantry base to access the horizontal drive. 2. Apply lithium grease with the grease gun on the zerk fitting shown in the photo to the right. 3. Also apply a small amount of grease to the rails inside the gantry base and to the two gear wheels at the motor.	

11.3.4.3 Vertical Drive

Procedure	*Details*
1. Remove the cover on the side of the Y-pillar.	

Procedure	*Details*
2. Use the grease gun to apply lithium grease through the zerk fitting on the ball screw nut as shown in the photo on the right.	
3. Remove the rotate gear cover and use the grease gun to apply lithium grease through the two zerk fittings on the bearing shown in the photo on the right.	

11.3.5 Deleting Old Log Files

The CardioMD stores information logging the operation of the system in log files in the directory `C:\cardiocam\SystemLog`. If the system log directory is not cleaned up from time to time, the acquisition PC's harddisk will eventually be filled up with log files. Therefore, on every service visit, you should delete all log files that are more than one month old.

12 CARDIOMD AC OPTION

Contents

12.1 Introduction

Attenuation correction is a method allowing the emission images acquired during SPECT acquisitions to be corrected for attenuation within the patient. The purpose of attenuation correction is to compensate for varying attenuation of gamma rays in the body.

The Attenuation Correction option is intended to provide the user with a means of measuring the attenuation of gamma rays within the patient's body when using the CardioMD System for SPECT studies, and to map the measured attenuation into images that can be used to correct emission images for the attenuation.

12.2 Overview

The CardioMD AC Option consists of two transmission scanners that mount onto the end piece of each CardioMD detector. The two scanners are identical, with the exception that they contain different software in the motion controller controlling the movement of the line source. For this reason, the two scanners are mechanically coded to prevent them being swapped by mistake.

CAUTION

Caution. It is possible to swap the transmission scanners and this may occasionally be required when troubleshooting the system. However, transmission scanners *must* be placed in their correct positions before the system is returned to the customer. While transmission scanners are swapped, it is not possible to perform a reference scan.

Each of the transmission scanners consists of the following parts:

- AC option bracket
- Line source compartment
- Line source housing with shutter
- Gd-153 line source.

Figure 12.1 shows the AC Option transmission scanner mounted on one of the detectors. The line source housing with the Gd-153 line source is located inside the line source compartment (see Figure 12.3, page 12-6).

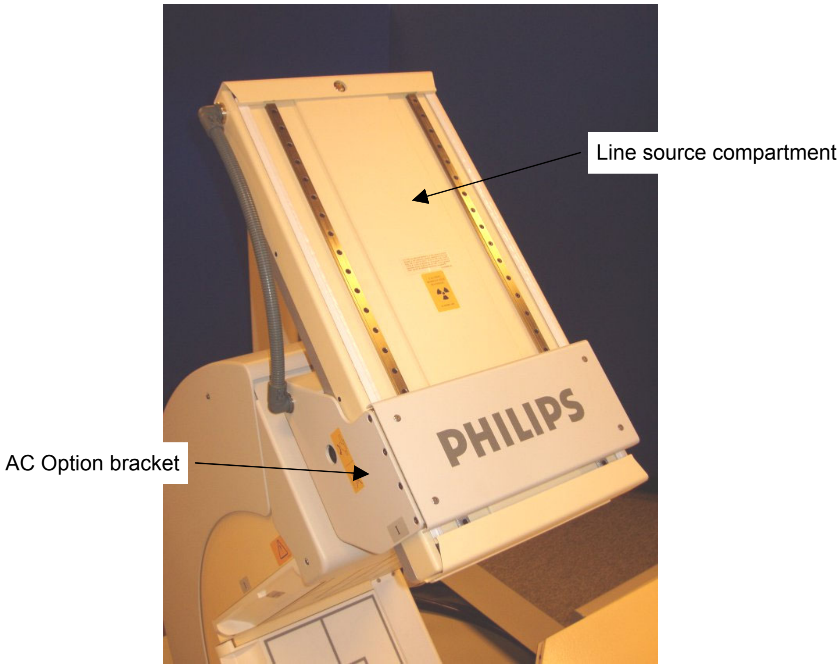


Figure 12.1 AC Option transmission scanner (line source compartment in IN position)

12.2.1 AC Option Bracket

The AC option bracket attaches the transmission scanner hardware to the detector end piece, ensuring that the line source within the scanner can expose the opposite detector.

The bracket contains a drive that moves the line source compartment in and out. When CardioMD is in the patient load position, the compartments are in their IN position as shown in Figure 12.1. When a transmission scan is being performed, the compartments are in their OUT position. In patient load position, the detector 2 compartment is placed in MID position (almost IN position).

12.2.2 Line Source Compartment

As part of automated motions bringing the detectors in position for imaging, the line source compartments are automatically translated in and out as required to obtain the various positions and for the detectors to rotate around the patient table. When the detectors have rotated to a position above the patient table, the compartments are automatically brought back to the IN position to allow for planar and non-AC SPECT imaging procedures.

While preparing for AC SPECT studies, the compartments translate to preparatory positions (one transmission scanner IN, the other OUT) before the detector is rotated to the mark position. When the acquisition is started, the second transmission scanner is translated to the OUT position to enable the internal line sources in both transmission scanners to scan the detector FOV to acquire transmission images.

The line source compartments can be moved manually by means of the emergency crank supplied with the CardioMD system. Instructions are provided in the CardioMD Operator's Manual Chapter 7 *CardioMD AC Option*. It is also possible to move line source compartments using the Windows HyperTerminal terminal emulator over a RS232 connection. See page 12-14 for details.

Figure 12.2 shows the location of the collision sensors on the AC Option.

Figure 12.2 Collision sensors on the CardioMD transmission scanner

12.2.3 Line Source Housing with Shutter and Attenuator

Figure 12.3 shows the line source housing inside the line source compartment.

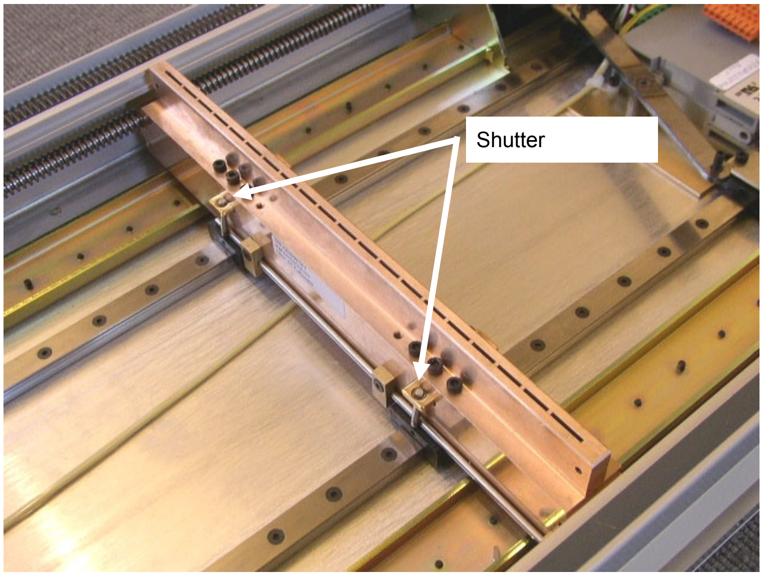


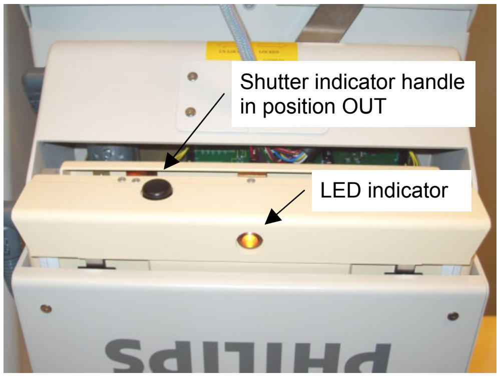
Figure 12.3 The line source housing with shutter mechanism

The line source compartment contains a drive enabling the line source to scan the detector FOV. Whenever the source is not in use during an AC SPECT acquisition or a maintenance procedure, the line source housing's shutter is closed.

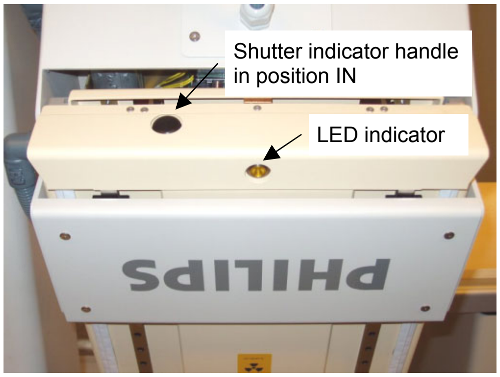
During transmission and reference scans, the line source housing's shutter opens and the line source scans across the detector FOV. The shutter is open during acquisition of AC SPECT and Gated SPECT studies and during acquisition of reference scans. At all other times, the shutter is closed.

On the end of the line source compartment, there is a knob allowing the line source shutter to be closed manually.

The status of the shutter is indicated by the position of the knob and by the status LED. When the shutter is open, the knob is OUT and the LED is ON. When the shutter is closed, the LED is OFF and the knob is in position IN. See Figure 12.4.



Shutter open



Shutter closed

Figure 12.4 Handle and LED indicating shutter position

After approximately one year of using a line source, the line source housing's built-in copper attenuator must be removed to enable extended use of the Gd-153 line sources. Instructions are provided in section 12.5.3.9, page 12-75. Approximately one year after attenuator removal, the Gd-153 sources will need to be replaced. See section 12.5.3.8, page 12-68.

12.3 Detailed Description

12.3.1 AC Option Block Diagram

The block diagram in Figure 12.5 illustrates the components of the AC option and their interfaces to the detector and gantry.

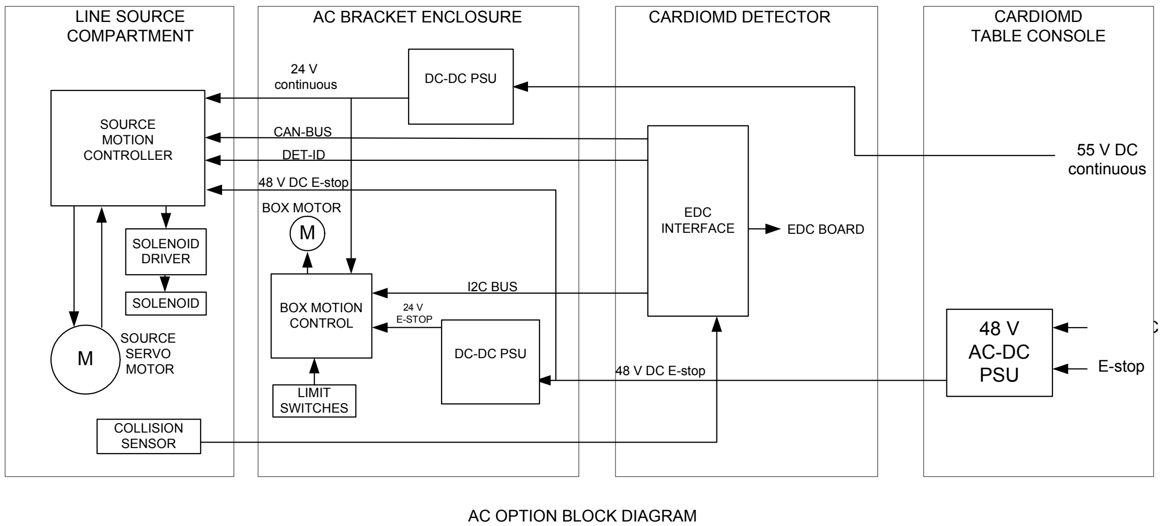


Figure 12.5. AC option schematic block diagram

12.3.2 Overview of Modifications

This section provides an overview of the electronic modules and cables added to the system to support the AC option.

12.3.2.1 System Interconnections

When the CardioMD AC option is installed, the internal wiring is modified. Figure 12.6 provides an overview of the wiring changes to the system.

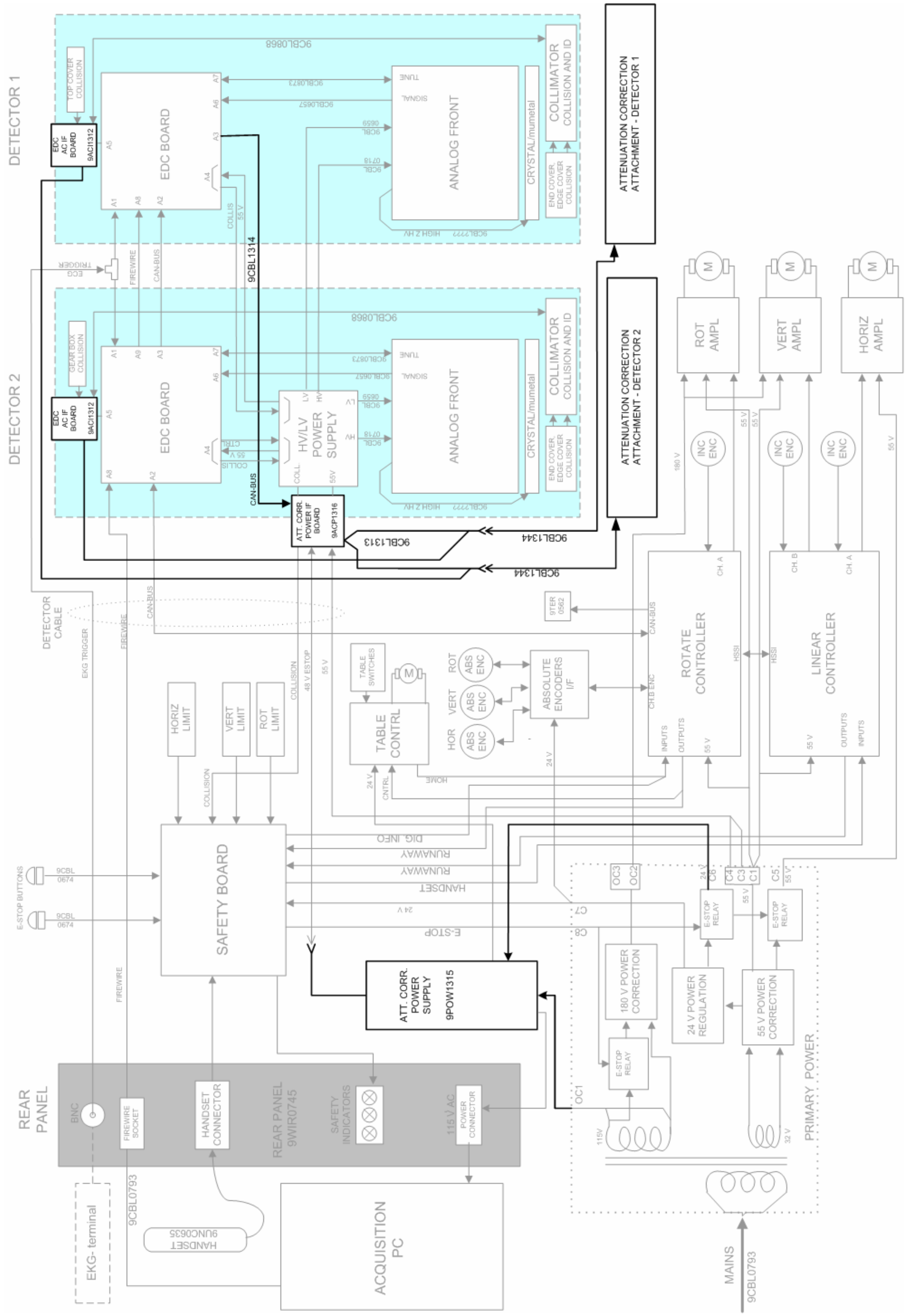


Figure 12.6 Interconnections with AC option installed (dark lines indicate AC option circuits)

12.3.2.2 Gantry

When the CardioMD AC option is installed, a dedicated power supply is installed inside the table console. This entails some modifications in the gantry cabling as illustrated in Figure 12.7.

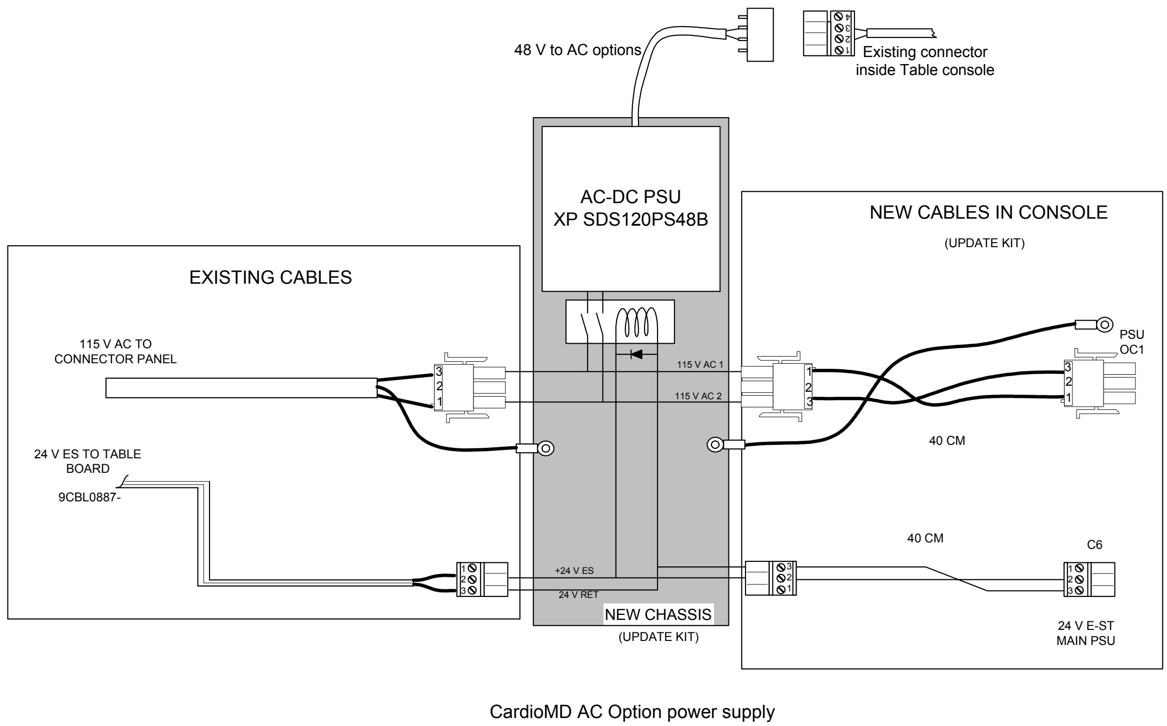


Figure 12.7 Modifications to gantry cabling when installing the AC option power supply

The continuous and safety interrupted outputs from the system power supply are now as shown in Table 12.1 and Table 12.2 below:

Connector Name	*Voltage*	*Function*
OC1	115V AC	ACQUISITION PC AND AC OPTION POWER SUPPLY
C1	55V DC	SPARE
C2	55V DC	DETECTOR 1 EDC BOARD AND DETECTOR PSU
C3	55V DC	DETECTOR 2 EDC BOARD
C4	55V DC	BOTH MOTION CONTROLLERS ROTATION AND VERTICAL AMPLIFIER*
C7	24V DC	SAFETY BOARD

* if these are of the type that requires 55 V DC input

Table 12.1 Continuous outputs

Connector Name	*Voltage*	*Function*
OC2	180V DC	ROTATE DRIVE AMPLIFIER
OC3	180V DC	Y DRIVE AMPLIFIER
C5	55V DC	X DRIVE AMPLIFIER
C6	24V DC	TABLE DRIVE AND AC OPTION POWER SUPPLY

Table 12.2 Safety interrupted outputs

12.3.2.3 Detector

The modifications of the detector cabling are illustrated in Figure 12.8.

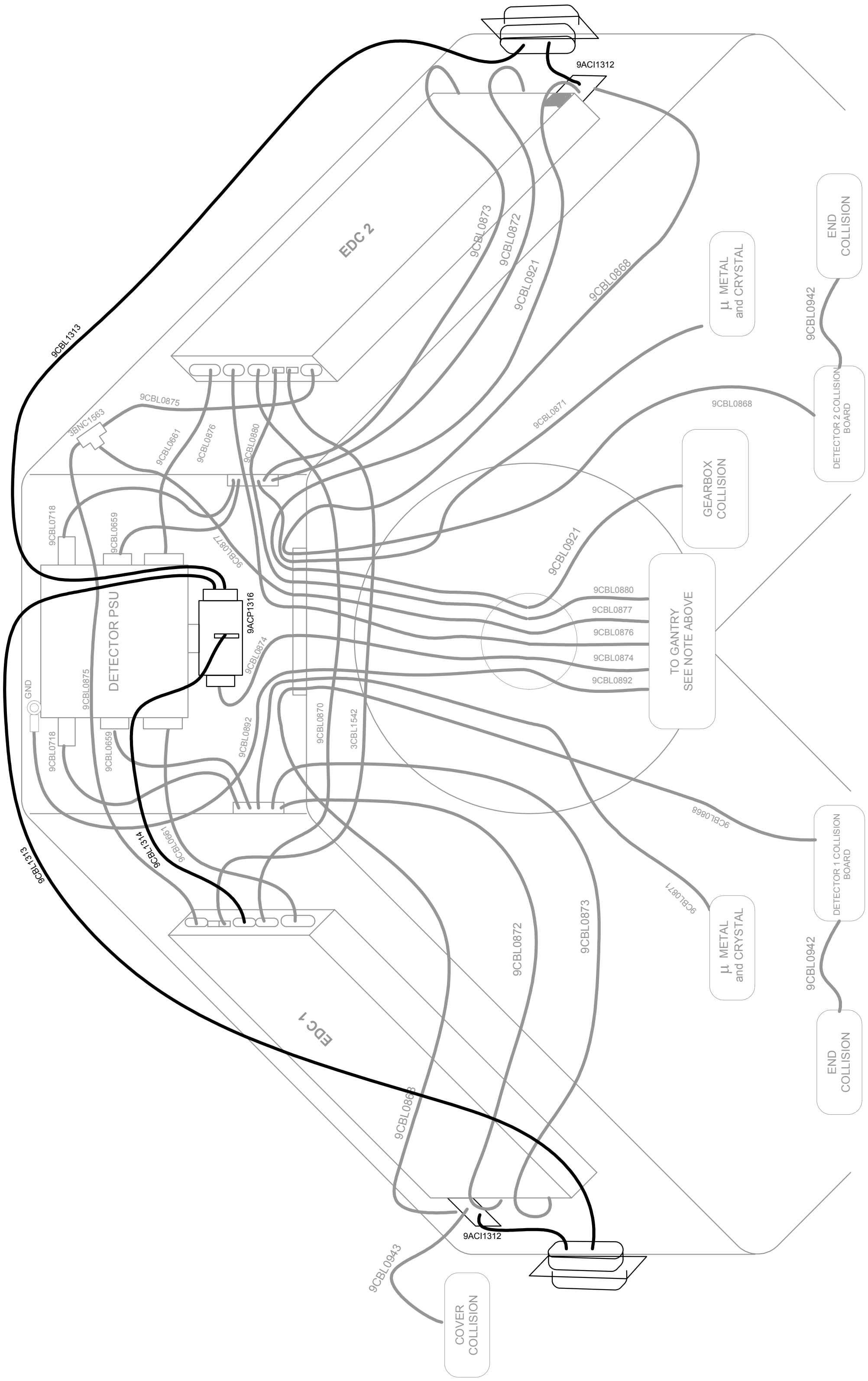


Figure 12.8 Detector layout under top cover with AC option (dark lines indicate AC option circuits)

12.3.3 AC Option Bracket

The AC option bracket attaches the AC option to the end of the detector casting and it contains the drive that moves the line source compartment in and out.

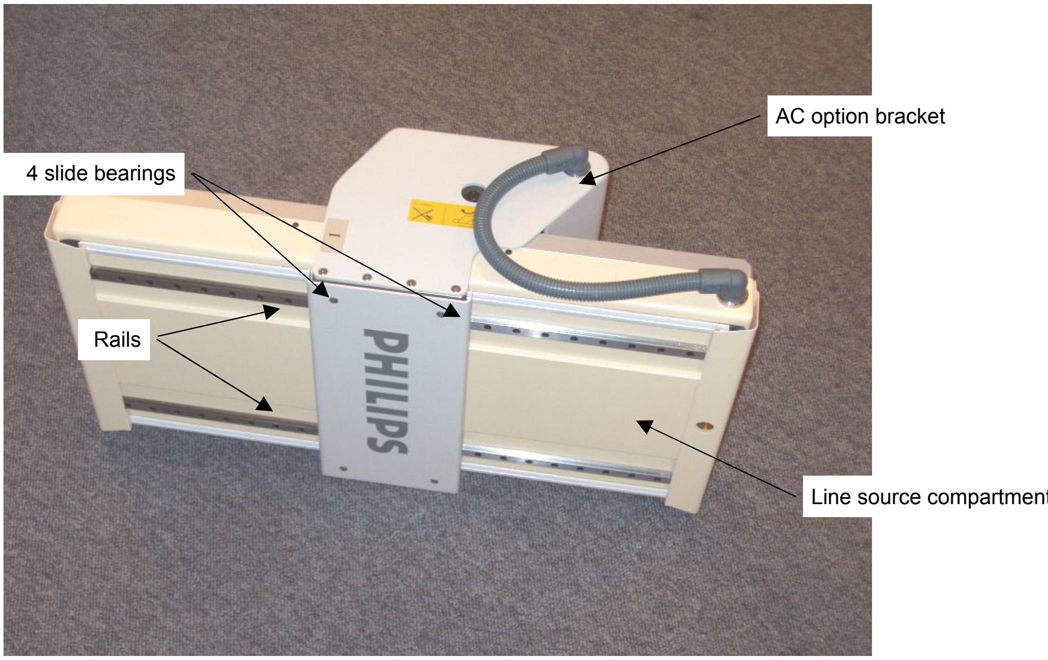


Figure 12.9 The AC option bracket seen from the outside

The bracket housing is made of aluminum plate welded to form a rigid base for the support of the complete AC option assembly.

12.3.3.1 AC Option Bracket Mechanics

Locking Mechanism

The locking mechanism consists of a steel plate and a handle. The steel plate is screwed onto the AC option bracket and cutouts in the plate allow the bracket to be mounted onto the guide pins of the detector housing. The handle locks the AC option in place.

Handle in open position

Handle in locked position

Figure 12.10 Bracket locking mechanism

Line Source Compartment Drive

On the inside of the bottom of the AC option bracket four slide bearings are mounted. These run on two rails mounted on the bottom plate of the line source compartment (see Figure 12.9), thus allowing the line source compartment to be translated in and out.

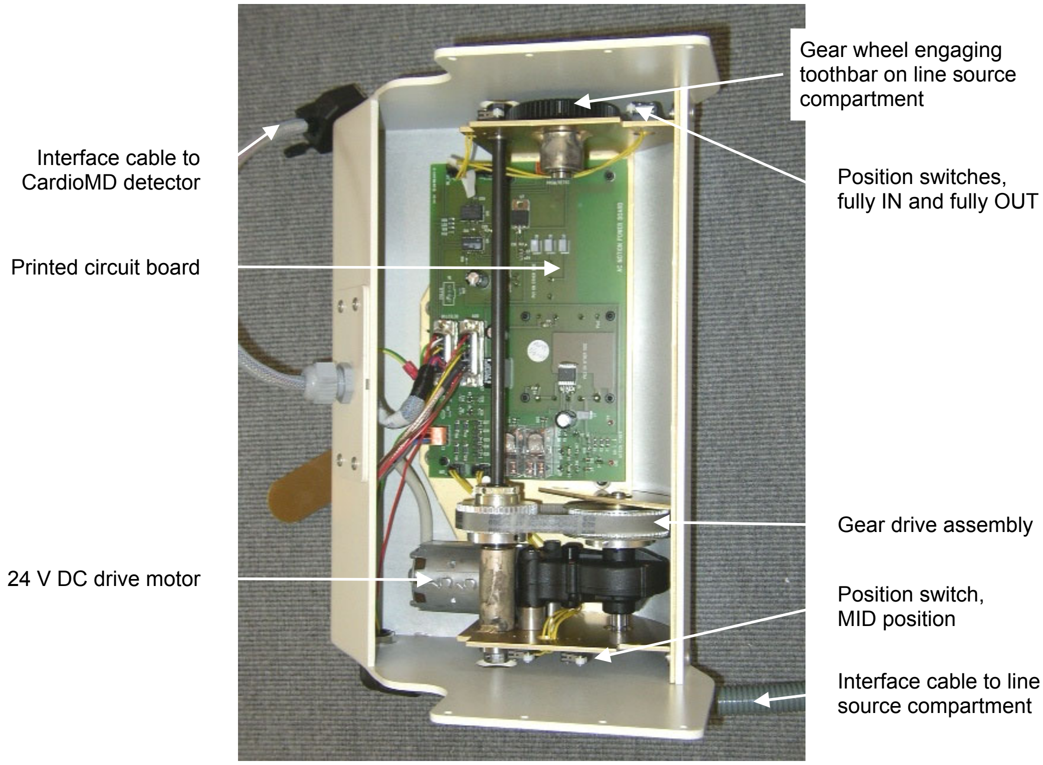


Figure 12.11 AC option bracket, inside

The AC option bracket motor is a 24 V DC motor used to translate the line source compartment in and out. The torque from the motor is transferred via the gear assembly to the gear wheel which engages a toothbar in the line source compartment.

12.3.3.2 AC Option Bracket Electronics

The AC bracket enclosure contains a printed circuit board carrying:

- The box motion controller, i.e. the device controlling the movement of the line source compartment
- Two DC-DC power converters providing the necessary supply voltages for the AC Option.

Box Motion Controller

Function

The box motion controller is based on a small flash-programmable micro-processor and a motor driver. The capabilities of the motion controller are as follows:

1. Move line source compartment fully IN (park position)
2. Move line source compartment fully OUT (scan position)
3. Move line source compartment to mid position.

Both end positions and the mid position are sensed by micro switches (see Figure 12.11). When the line source is in the desired position, the motor is stopped.

Interface

The motion controller is connected to the detector EDC board's collimator ID EEPROM interface. The EDC board firmware emulates an EEPROM function in which a register address is used as control and status register for the motion control function. This enables the acquisition PC to control this motion.

Trouble-shooting and Manual Control of Motions

To trouble-shoot the box motion controller, you connect a PC to the RS232 interface of the EDC board. For instructions on connecting the PC and using the HyperTerminal program, see Chapter 5 *Diagnostics*, the section *EDC Module Diagnostics*.

To read the motion controller's status register, issue the command:

```
-> eeprom 1 0x240
```

The significance of the response is as follows:

`x1` Line source compartment is in scan position (OUT)

`x2` Line source compartment is in mid position

`x4` Line source compartment is in park position (IN)

`x8` Error: illegal switch combination

`1x` Line source compartment moving towards scan position (OUT)

`2x` Line source compartment moving towards mid position

`4x` Line source compartment moving towards park position (IN)

`8x` Error: Motion of line source compartment stopped due to an error (switch error or motor power off caused by e.g. collision or activation of E-Stop)

`0x` Line source compartment stopped without error.

You can control the motions of the line source compartment manually by writing the motion controller's control register. To write the motion controller's control register, issue the command:

```
-> eeprom 1 0x240 <cmd>
```

where `<cmd>` is one of the following:

`0x10` Move to scan position (OUT)

`0x20` Move to mid position

`0x40` Move to park position (IN)

`0x00` Stop motion in progress.

DC-DC power converters

One DC-DC converter is powered from 55 V from the gantry AC mains power supply and continuously provides 24 V for the box motion controller and the line source motion controller residing inside the line source compartment.

The other DC-DC converter is powered from E-Stop controlled 48 V provided by the AC option power supply in the gantry. This DC-DC converter provides E-Stop controlled 24 V for the motor moving the line source compartment, the line source and the shutter.

The PCB has a DB15 connector for the flexible cable to the line source compartment and another DB15 connector for the cable to the CardioMD detector.

12.3.4 Line Source Compartment

The line source compartment is made of aluminum plate and consists of a bottom part in the form of an open box with two top covers.

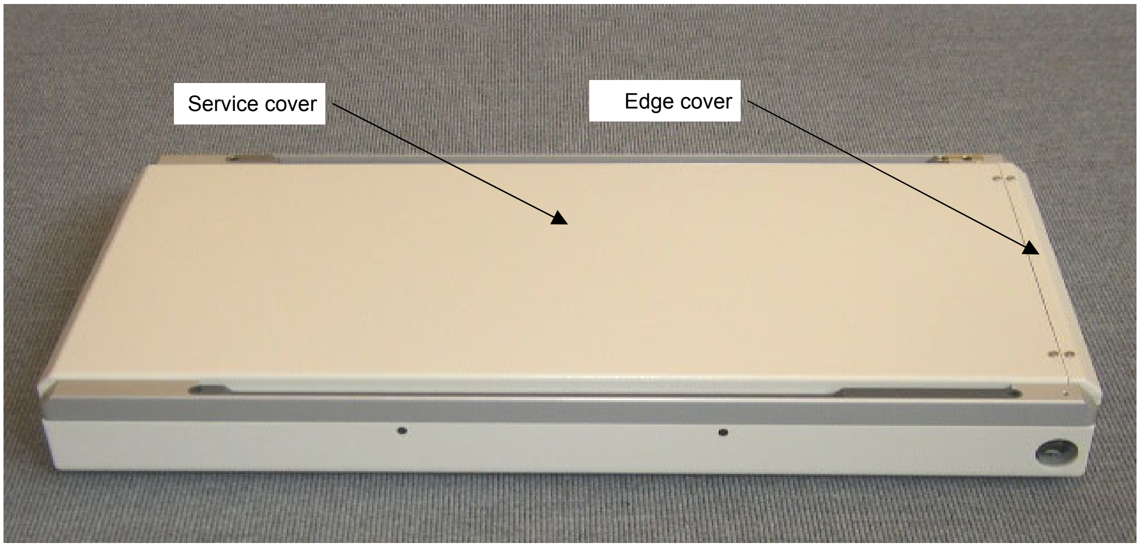


Figure 12.12 Line source compartment, outside view

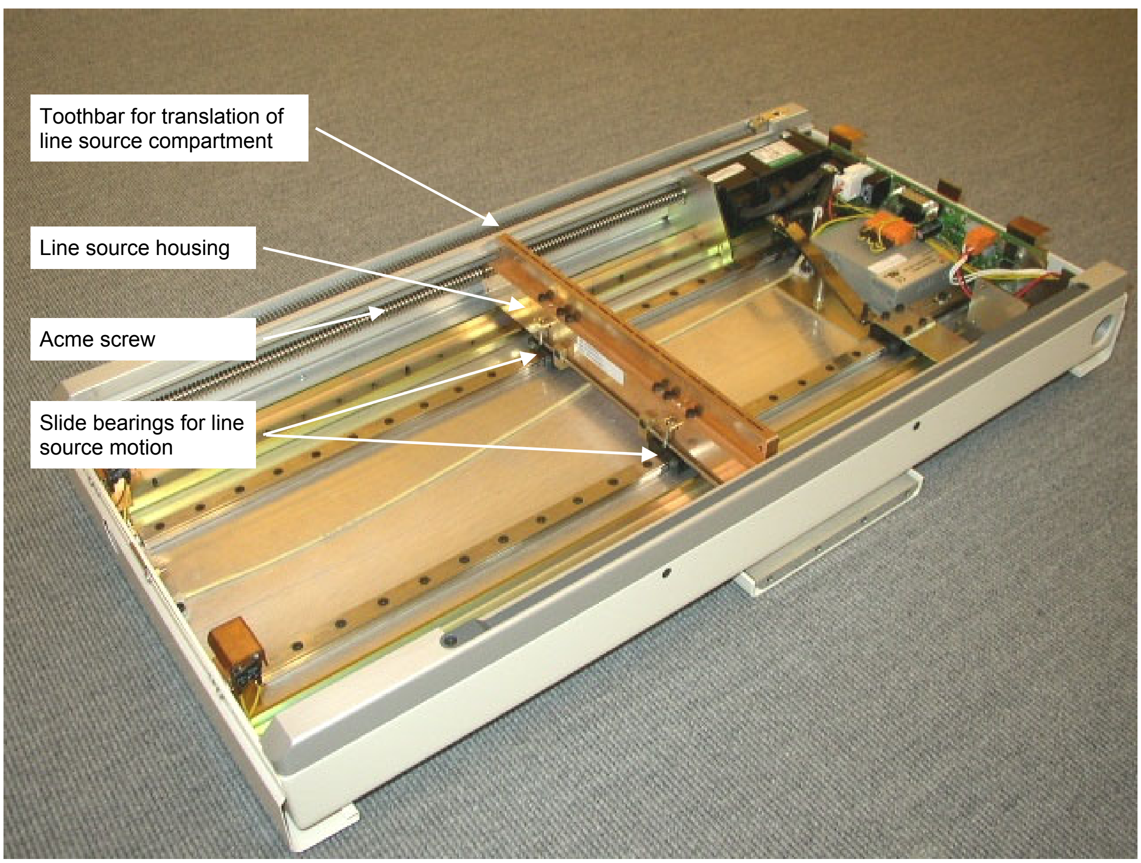


Figure 12.13 Line source compartment, inside view

12.3.4.1 Line Source Compartment Mechanics

Line Source House Motion

Inside the line source compartment are mounted two rails supporting two slide bearings. The line source housing is mounted on top of the slide bearings (see Figure 12.13 on page 12-16) and can thus be translated from one end of the line source compartment to the other.

Figure 12.14 gives a more detailed inside view of the line source housing.

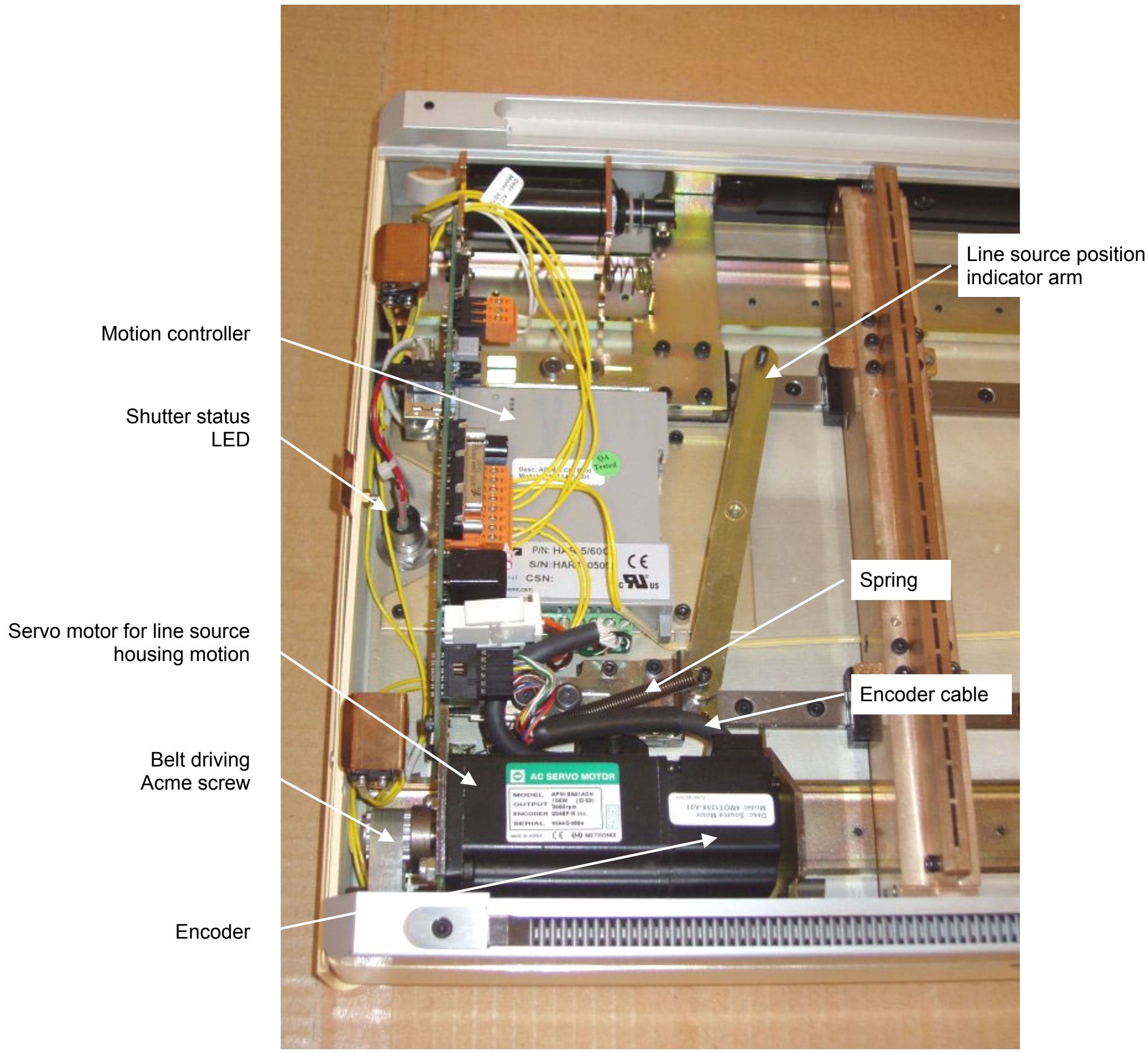


Figure 12.14 Components involved in line source motion

The motion controller controls the servo motor driving the line source in its housing. The torque from the servo motor is transferred via a belt to the Acme screw (see Figure 12.13), which is mounted underneath the toothbar.

Note. Carefully route the encoder cable to prevent interference with the line source position indicator arm.

Sensing the Position of the Line Source Housing

The line source compartment has a mechanism that detects when the line source is in the park position. When the line source housing approaches the park position, it will push the indicator arm, as you can see from Figure 12.14. The indicator arm pulls a plate mounted on a slide bearing away from the optocoupler, enabling current through the optocoupler (shown in Figure 12.15), and thereby signaling to the motion controller. The indicator arm is supplied with a spring (shown in Figure 12.14 but not in Figure 12.15), which will pull it back in position when the line source moves away from the park position again.

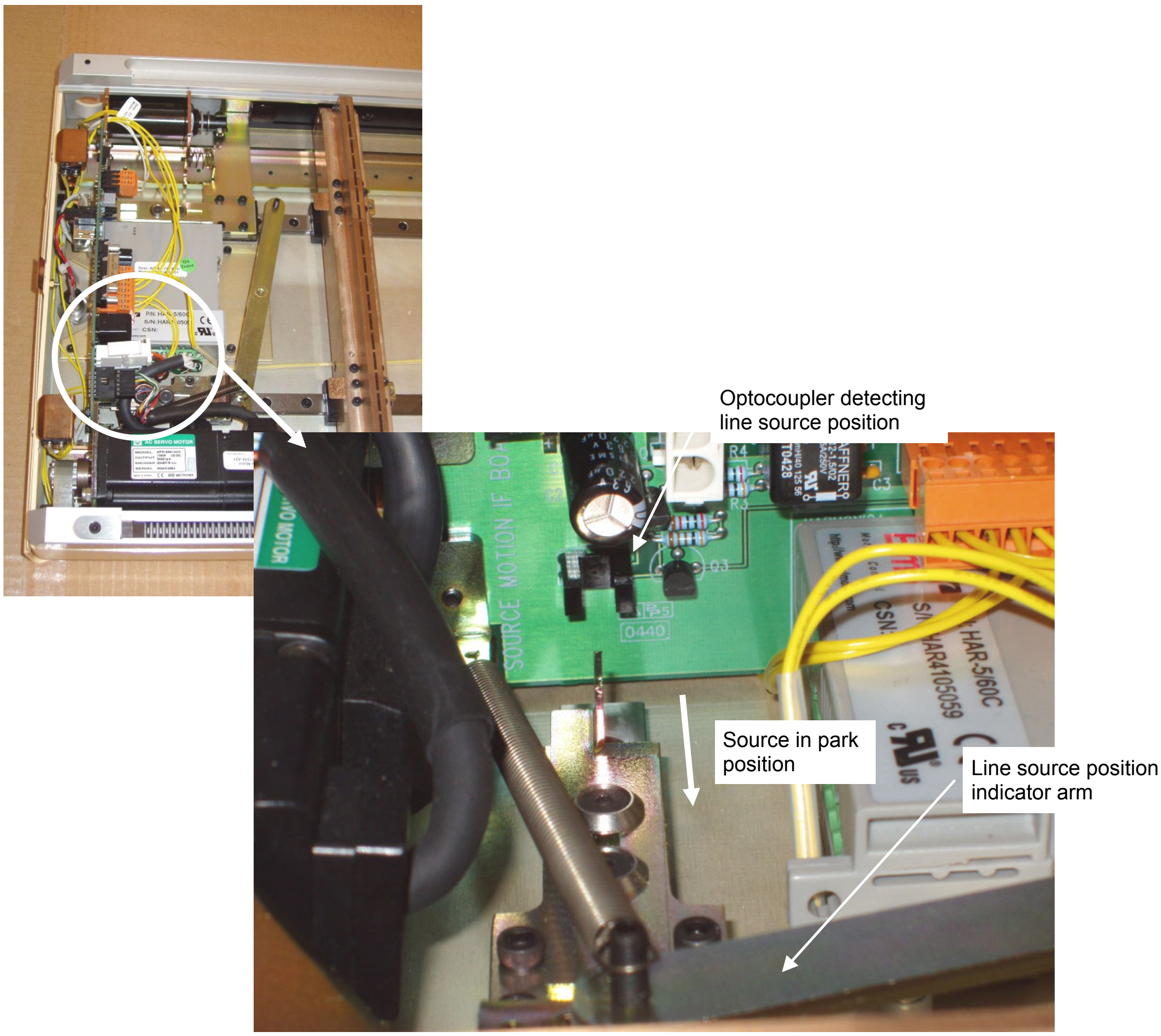


Figure 12.15 The mechanism sensing the position of the line source

Line Source Housing

The line source housing contains the Gd-153 line source. The line source housing is manufactured from a lead-bronze alloy and has a 1.5 mm aperture. Thus, the line source housing serves as a collimator, collimating the radiation from the line source in both the x (30 mm resolution) and y directions (200 mm resolution).

WARNING

The line source housing must *not* be taken apart. When the line source needs to be replaced, the entire line source housing is returned to the supplier. See the section *Returning the Used Line Source to the Vendor*, page 12-74 for instructions.

Due to the Gd-153 source, the CardioMD line source housings contain significantly higher levels of radiation than normally used in clinical imaging. Potential for radiation exposure exists. Use good radiation safety practices.

Handling of line source housings with Gd-153 sources installed shall only be performed by Philips Nuclear Medicine employees that have had radiation safety training classes and trained on proper handling of radioactive material.

Radiation from the line source is shut off / activated by means of a shutter. Furthermore, the line source housing has an attenuator permitting reduction of radiation from a new line source.

Shutter Mechanism

The shutter closes the line source housing's aperture, thereby shutting off radiation from the line source.

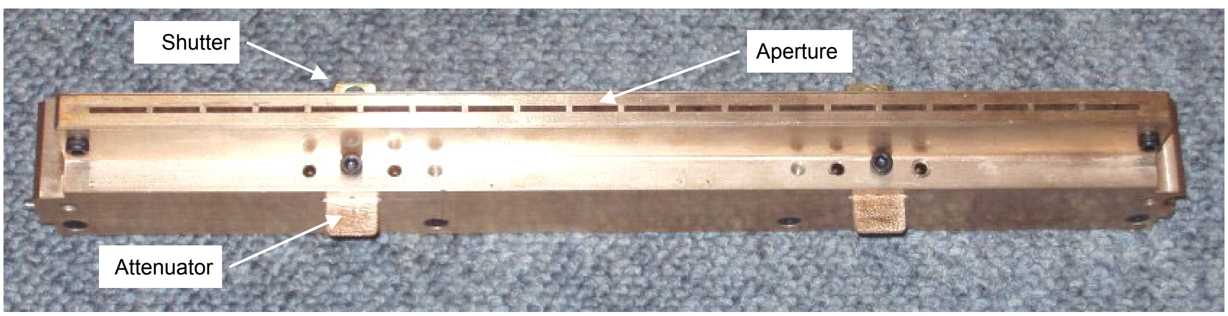


Figure 12.16 Line source housing with shutter and attenuator

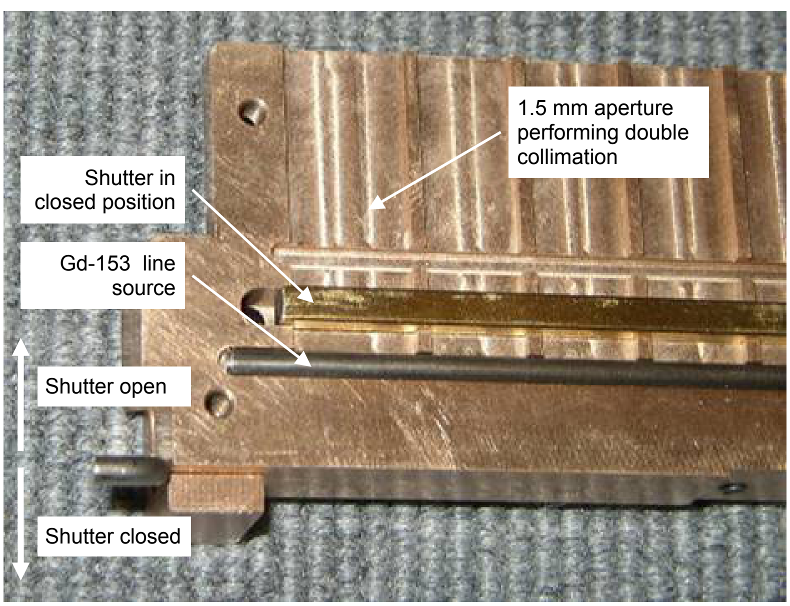


Figure 12.17 Inside of line source housing showing shutter mechanism

WARNING

The line source housing must *not* be taken apart. Figure 12.17 only serves to clarify the explanation.

The lever shown at the bottom left in Figure 12.17 activates the shutter. The shutter is spring-loaded, which means that it defaults to the closed position in case of a power loss or an error condition.

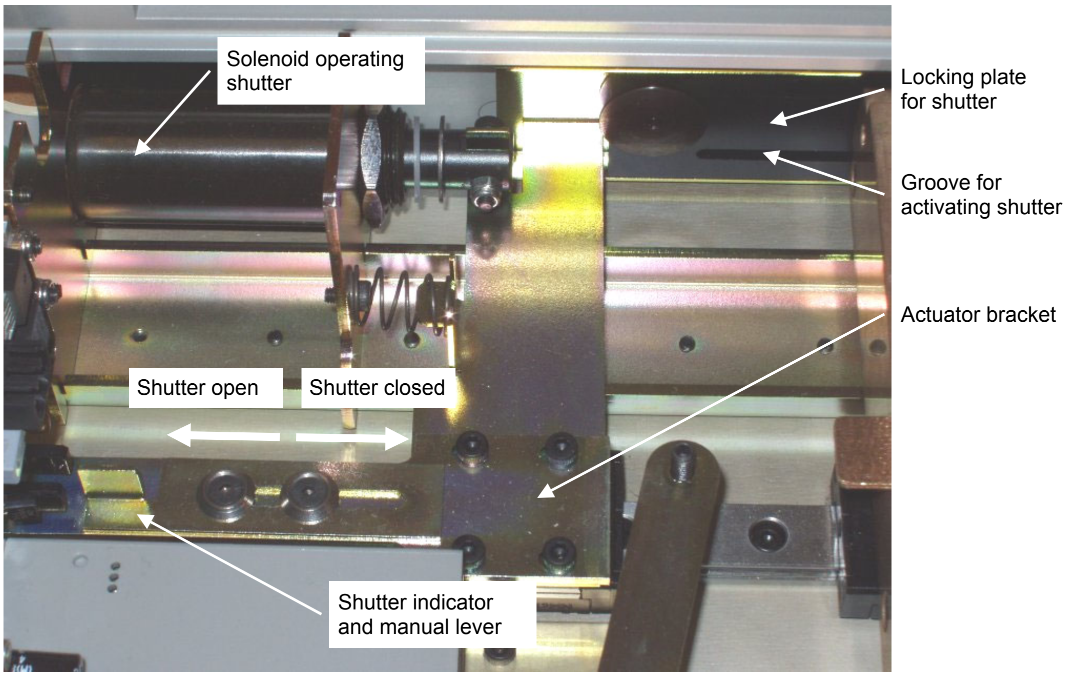


Figure 12.18 Shutter operating mechanism outside line source housing

As shown in Figure 12.18, the line source compartment contains a solenoid. When the solenoid is activated electrically, it moves the actuator bracket, which rests on a slide bearing. The actuator bracket, in its turn, moves the shutter indicator / manual knob out. At the same time, the locking plate is lifted and its built-in groove activates the shutter lever on the line source housing (see Figure 12.17), thereby causing the shutter to open. The groove in the locking plate runs the entire length of the line source housing's trajectory, thus ensuring that the shutter can be operated regardless of the position of the line source housing.

The position of the shutter is sensed by an optocoupler as shown in Figure 12.19.

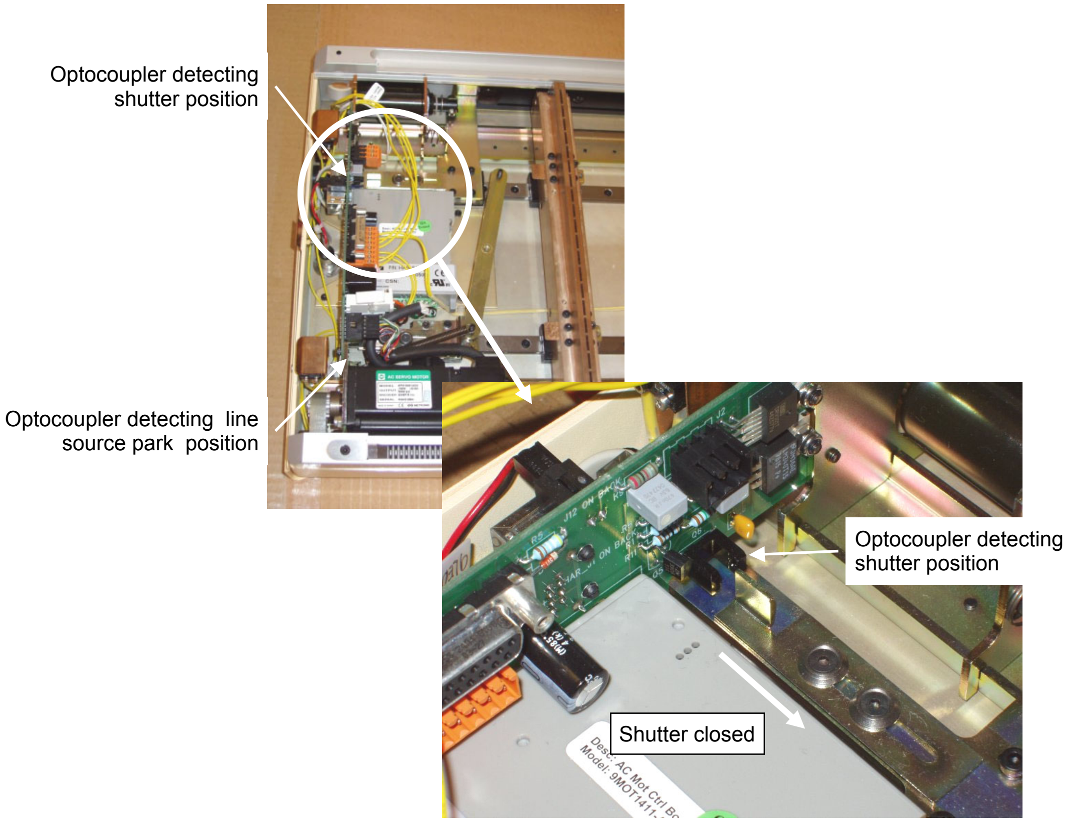


Figure 12.19 Shutter position sensing

In case of a power failure or error condition, the spring automatically closes the shutter. However, in case of faults you can close the shutter by pushing in the manual shutter knob. The shutter cannot be opened by means of the knob.

When the shutter is open, this is indicated by:

- The manual shutter knob is in the OUT position
- The line source compartment's built-in shutter status LED is ON (see Figure 12.14 on page 12-17).

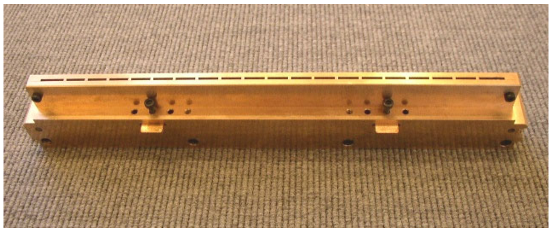
Attenuator

When the Gd-153 source is fresh, the radiation from the line source must be reduced. However, as the line source grows older, you will want to take advantage of its full radiation capacity. The line source housing attenuator allows just that.

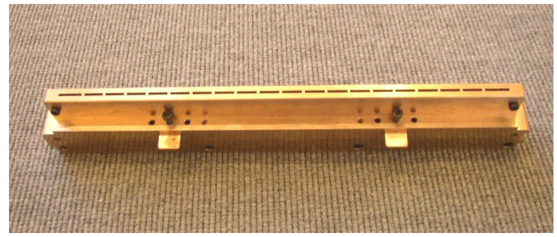
The attenuator consists of 4 copper strips that are mounted on top of each other in the line source housing. When the line source is delivered from the manufacturer, all four strips are in place covering the aperture of the line source housing. When the line source is growing too weak, *all four* strips are retracted from the aperture.

CAUTION

Caution. All 4 copper strips of the attenuator must be in the closed position when the line source is new. Likewise, all 4 strips must be retracted and placed in the open position when the attenuator is removed. For instructions, see section 12.5.3.9, page 12-75.



Attenuator in closed position



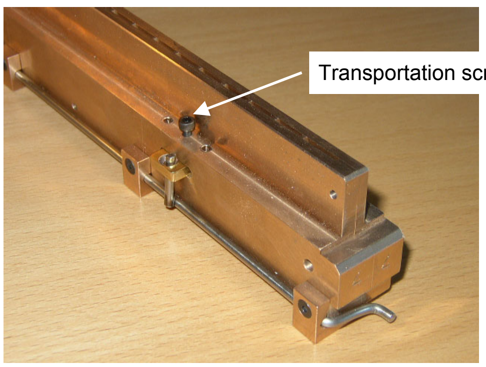
Attenuator retracted

Figure 12.20 Attenuator

Preparing for Transportation

When the line source housing is going to be transported, e.g. being shipped from the supplier to the customer site, the shutter is locked in the closed position. This prevents uncontrolled radiation from the source if the shutter lever on the line source housing should be activated by mistake.

The shutter is locked by inserting two 3 mm transportation screws into the line source housing and through dedicated holes in the shutter plate as illustrated in Figure 12.21.



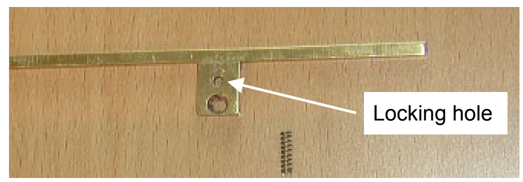


Figure 12.21 Locking the shutter for transportation

Covers

The AC option includes two aluminum covers, both mounted on the line source compartment:

- A small edge cover
- A larger service cover.

These are shown in Figure 12.12, page 12-16.

12.3.4.2 Line Source Compartment Electronics

The printed circuit board inside the line source compartment, the AC source motion board, carries:

- The line source motion controller
- A driver circuit for the solenoid
- An interface to the collision pad.

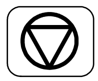
The board has a DB15 connector for the flexible cable to the AC bracket.

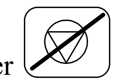
Line Source Motion Controller

Function

The movement of the line source is controlled by a small, compact motion controller, connected directly to a 3-phase brushless servo motor (see Figure 12.14, page 12-17). The motion controller is supplied from two voltage sources:

- A 24 V supply to the processor, internal logic and interface
- A 48 V supply to the motor.

The 48 V motor power will be interrupted in the event of a collision, activation of the E-Stop or the hand controller  Motion Stop button.

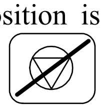
The motion controller includes a small program that calibrates the line source position when the gantry is powered up and after the hand controller  Collision Override button is activated. All configuration and control of line source motion takes place from the acquisition PC via the CANbus interface.

Interface

The programmable part of the line source motion controller communicates via the CANbus. In addition to the CANbus, 3 inputs on the line source motion controller are allocated as follows:

1. Input from optocoupler detecting the position of the solenoid controlling the shutter
2. Input from optocoupler detecting the position of the line source (in or away from park position)
3. Input from EDC board detecting the ID of the CardioMD detector on which the AC unit is mounted.

The line source motion controller also receives incremental encoder pulses from the servo motor moving the line source.

After the CardioMD acquisition software is started, the necessary configuration of the line source motion controller's CANbus interface takes place. Therefore, if power to the AC option is cut, for example when the AC Option is removed and remounted, the acquisition software must be restarted before the line source can be used to perform an AC study. Furthermore, since the line source position is not calibrated until power to the motors is enabled by means of the hand controller  Collision Override button, it is necessary to wait for at least 10 seconds after pressing Collision Override before an acquisition can be started.

Note. After removing and remounting the CardioMD AC option, make sure to power cycle the CardioMD system and enable power to the motors by pressing Collision Override *before* restarting the acquisition software. Wait for 10 seconds after pressing Collision Override before starting the software.

Note. If the system is power-cycled, at least 30 seconds of power-down time is required in order to completely and accurately reset motion controllers and CANbus.

Motion Calibration

Calibration of the line source motion takes place automatically by moving the line source all the way to the mechanical end stop closest to the motor (see the section *Sensing the Position of the*

Line Source Housing, page 12-18). Depending on the distance the line source has to move, this procedure takes from 3 to 10 seconds.

The line source can only be controlled from the acquisition PC, not from the hand controller.

Shutter Control

The line source compartment's shutter mechanism is operated via an output port of the motion controller. The shutter can only be opened when motor power is present (48 V). Unlike the rest of the motion controller's CANbus interface, the shutter CANbus commands do not require any previous configuration of the motion controller CANbus interface. Thus, the fact that the shutter opens and/or closes does *not* indicate that the CANbus interface has been correctly configured.

Indicators

The motion controller has a single LED, which is visible through the printed circuit board next to the RJ45 connector to the CANbus. The significance of the LED is explained in Table 12.3.

LED condition	***Signifies***
OFF	Power supply to line source motion controller logic and interface is OFF, or motion controller is defective
Red	Power to line source motion controller motor supply is OFF due to a collision, E-Stop or power supply error
Green	Motion controller hardware ready for operation

Table 12.3 Line source motion controller LED indication

Manual Control of Line Source Motions

It is possible to control the motions of the line source housing and of the shutter manually. To do this, a PC must be connected to one of the EDC boards (which one is not important) via its RS232 interface.

Motion commands are issued via the Windows HyperTerminal program. For instructions on connecting the PC's serial interface to the EDC board and using the HyperTerminal program, see Chapter 5 *Diagnostics*, the section *EDC Module Diagnostics*. Alternatively, you can use another terminal emulator program, for example ttermpro. The use of this program is described in Chapter 7 *Software Update Procedures*.

Table 12.4 details commands used for manual operation of the line source shutter. Note that `->` is the command prompt issued by the EDC board indicating that the EDC board is connected and waiting for a command).

Detector	***Shutter Operation***	***Command***
1	Open	`-> canmsg 0x314 0x4f 0x42 1 0 1 0 0 0`
	Close	`-> canmsg 0x314 0x4f 0x42 1 0 0 0 0 0`
2	Open	`-> canmsg 0x315 0x4f 0x42 1 0 1 0 0 0`
	Close	`-> canmsg 0x315 0x4f 0x42 1 0 0 0 0 0`

Table 12.4 Commands for manual control of line source shutter

Table 12.5 details the command sequences required in order to move the line source housing inside the line source compartment.

Note. Manual control of the motions of the line source housing requires that the acquisition PC has already initialized the line source motion controller. This initialization takes place during system start-up. If the line source motion controller has not been properly initialized, it is *not* possible to move the line source housing manually.

Detector	*Move line source to*	*Command sequence*

1	0 mm
	(park position – closest to motion controller)
		`-> canmsg 532 0x80 0`
		`-> canmsg 532 0x06 0`
		`-> canmsg 532 0x0F 0`
		`-> canmsg 532 0x0F 0`
		`-> canmsg 1300 0 0xc0 3 0 0 0xc0 3 0`

		`-> canmsg 1044 0 0 0 0 0xaa 0xaa 2 0`
		`-> canmsg 532 0x1f 0`
		`-> canmsg 532 0x6f 0`

	200 mm
	(mid position)
		`-> canmsg 532 0x80 0`
		`-> canmsg 532 0x06 0`
		`-> canmsg 532 0x0F 0`
		`-> canmsg 532 0x0F 0`
		`-> canmsg 1300 0 0xc0 3 0 0 0xc0 3 0`

		`-> canmsg 1044 0x55 0x55 8 0 0xaa 0xaa 2 0`
		`-> canmsg 532 0x1f 0`
		`-> canmsg 532 0x6f 0`

	400 mm
	(position furthest from motion controller)
		`-> canmsg 532 0x80 0`
		`-> canmsg 532 0x06 0`
		`-> canmsg 532 0x0F 0`
		`-> canmsg 532 0x0F 0`
		`-> canmsg 1300 0 0xc0 3 0 0 0xc0 3 0`

		`-> canmsg 1044 0xaa 0xaa 0x10 0 0xaa 0xaa 2 0`
		`-> canmsg 532 0x1f 0`
		`-> canmsg 532 0x6f 0`

2	0 mm
	(park position – closest to motion controller)
		`-> canmsg 533 0x80 0`
		`-> canmsg 533 0x06 0`
		`-> canmsg 533 0x0F 0`
		`-> canmsg 533 0x0F 0`
		`-> canmsg 1301 0 0xc0 3 0 0 0xc0 3 0`

		`-> canmsg 1045 0 0 0 0 0xaa 0xaa 2 0`
		`-> canmsg 533 0x1f 0`
		`-> canmsg 533 0x6f 0`

	200 mm
	(mid position)
		`-> canmsg 533 0x80 0`
		`-> canmsg 533 0x06 0`
		`-> canmsg 533 0x0F 0`
		`-> canmsg 533 0x0F 0`
		`-> canmsg 1301 0 0xc0 3 0 0 0xc0 3 0`

		`-> canmsg 1045 0x55 0x55 8 0 0xaa 0xaa 2 0`
		`-> canmsg 533 0x1f 0`
		`-> canmsg 533 0x6f 0`

Detector	*Move line source to*	*Command sequence*

	400 mm
	(position furthest from motion controller)
		`-> canmsg 533 0x80 0`
		`-> canmsg 533 0x06 0`
		`-> canmsg 533 0x0F 0`
		`-> canmsg 533 0x0F 0`
		`-> canmsg 1301 0 0xc0 3 0 0 0xc0 3 0`
		`-> canmsg 1045 0xaa 0xaa 0x10 0 0xaa 0xaa 2 0`
		`-> canmsg 533 0x1f 0`
		`-> canmsg 533 0x6f 0`

Table 12.5 Commands for manual positioning of line source housing

Note. In Table 12.5, some of the commands to be sent to the line source motion controller are printed on a gray background. These commands serve to reset the motion controller and need only be sent to the motion controller once.

Solenoid Driver

The driver for the solenoid activating the shutter (see Figure 12.18, page 12-20) is a switch-mode type, powered from the E-Stop controlled 48 V supply. For the first 0.5 second after the driver is activated, it operates at 100 % duty cycle. After this, it operates at 27 % duty cycle. The solenoid driver is activated from an output port on the line source motion controller.

12.3.5 CardioMD Detector and Table Console

When the CardioMD AC Option is installed, the CardioMD detector and table console are provided with additional 3 dedicated circuit boards, a 48 V PSU and associated cables. See AC installation chapter for details.

12.4 Calibration

12.4.1 Point Source Holder

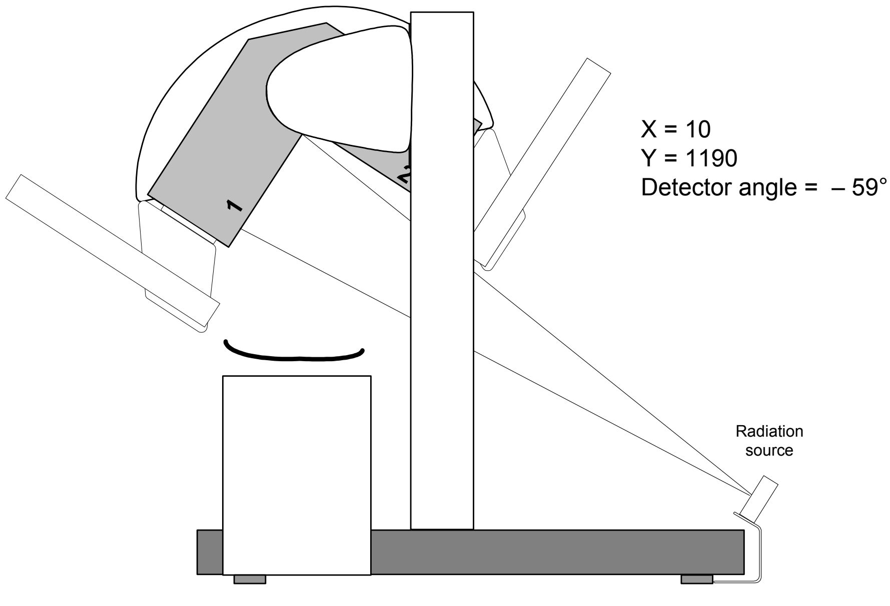
When the AC option is mounted on the CardioMD system, it is not possible to use the tripod point source holder for performing detector checks and calibration. Instead, you must use the dedicated point source holder shown in Figure 12.22.

Figure 12.22 Point source holder to be used with AC option

The gantry and source positions are shown in Figure 12.23. The point source holder is designed to be placed on the floor and will hold the point source at the correct angle.

Note. For checks and calibration of detector 1, the point source holder is slid onto the base of the CardioMD gantry from the side. This permits calibration of detector 1 even when the CardioMD system is installed in a room of the minimum required size.

Gantry and source position for PMT update
and intrinsic QC check of detector 1



Gantry and source position for PMT update
and intrinsic QC check of detector 2

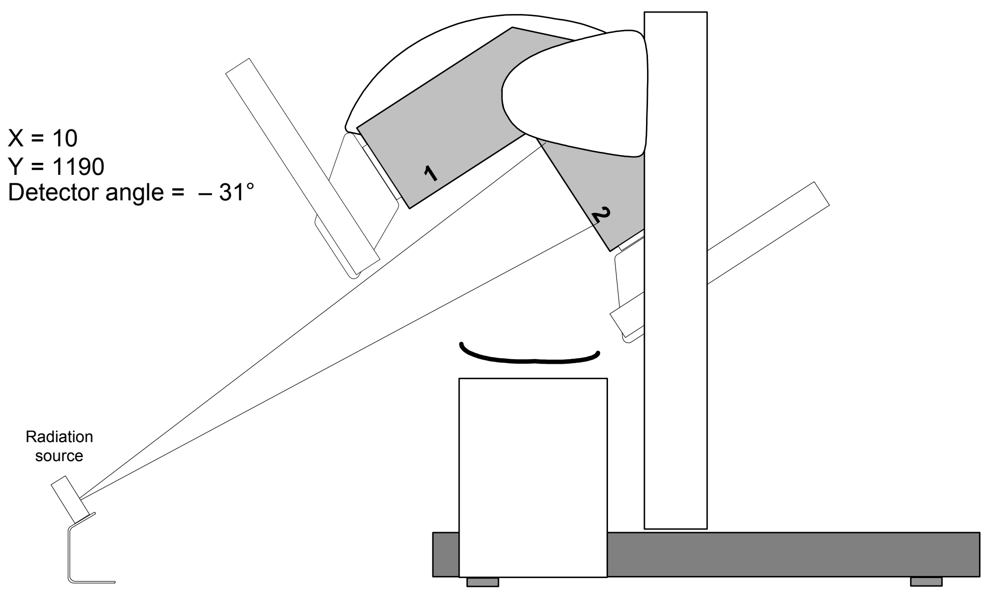


Figure 12.23 Gantry position for detector check and calibration with the AC option mounted

Instructions for using the AC option point source holder are provided in Chapter 7 *CardioMD AC Option* of the CardioMD Operator's Manual.

12.5 Repair Procedures

To perform repairs on the CardioMD AC Option, you need standard tools, particularly:

- A set of Torx keys in the range of T6 – T20
- A set of Allen keys in the range of 2 – 5 mm.

Replacing parts specific to the CardioMD AC Option within the CardioMD gantry and detectors is straightforward. Therefore, no instructions are provided. Refer to section 12.7, page 12-109 for part number information on replaceable parts.

Before performing any repairs on the AC Option transmission scanner, the scanner must be dismounted from the CardioMD detector.

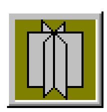
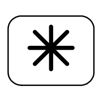
After the scanner has been dismounted from the detector, the line source compartment must be dismounted from the AC Option bracket.

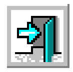
To remove the transmission scanner from the detector, proceed as outlined in the following section.

12.5.1 Dismounting Transmission Scanners

12.5.1.1 Removing Transmission Scanners from the Detectors

Positioning the Gantry

Procedure	*Details*
1. Ensure that the acquisition PC is displaying the Persistence page.	
The fastest and safest way to position the gantry conveniently for accessing both transmission scanners is to use the SPECT acquisition setup as follows:	
2. Click the SPECT Acquisition button.	
3. On the SPECT acquisition page, ensure that the setup is as follows: Rotation: CW.	
It does not matter whether a circular or non-circular orbit is selected.	
4. Click Prepare Gantry and then OK to accept automated motions bringing the system to marking position.	
5. Press the hand controller Mark button to enter a mark (the position is of no importance as long as it is within the range permitted by the system).	
6. Click OK to accept automated motions bringing the system to the acquisition start angle.	

Procedure	***Details***
7. Click the Exit button to return to the Persistence page.	
8. If required, use the hand controller to fine adjust the position of the detector assembly.	
A convenient position is approximately: Det ang.: – 45° Det Y: 1180 mm Det X: 0 mm.	

CAUTION

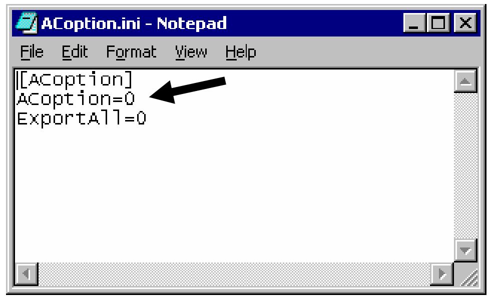
Caution. Exercise caution when using the hand controller to position the gantry. Observe that the transmission scanners and other parts of the detector assembly do not collide with the patient table or other objects.

Procedure	***Details***
9. On the acquisition PC, click the Close button in the upper right corner of the Persistence page to close down the CardioMD application.	

Reconfiguring the CardioMD Software

The following steps describe how to modify the CardioMD system's software configuration for use *without* the AC option. However, these steps need only be performed if the camera is to be used without the AC option. If you are just removing the transmission scanners for service purposes, proceed to the section *Powering Down the Gantry* on page 12-31.

Procedure	***Details***
10. Click the Windows Start button.	
11. Then select **Programs**, **Accessories** and **Notepad**.	
12. In the Notepad window, select **File**, **Open**.	
13. In the Open dialog box, select **All files** from the **Files of Type** drop-down list.	
14. Select the file: `C:\Cardiocam\ACoption.ini` and click Open.	

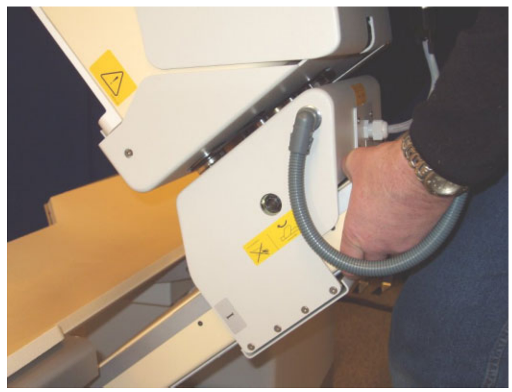
Procedure	***Details***
The contents of the `ACoption.ini` file determine whether the AC option is active or not. The arrow in the figure on the right indicates the entry to look for. 15. To disable the CardioMD AC Option, edit the entry to say `ACoption=0`. This setting allows the CardioMD system to function without the AC option. 16. Select **File**, **Save** to save the modified file. 17. Click the Close button to close down the Notepad program.	 CardioMD configuration file – AC option disabled 

Powering Down the Gantry

Procedure	***Details***
Close down the acquisition PC and power off the CardioMD gantry: 18. Follow the system shutdown procedure provided in Chapter 3 *Getting Started* of the CardioMD Operator's Manual.	

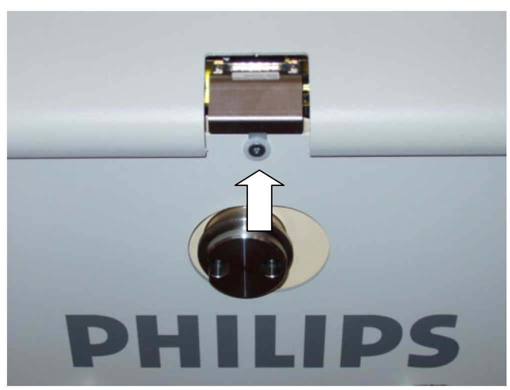
Detaching the Transmission Scanner

Procedure	***Details***
19. Unscrew and disconnect the cable to the transmission scanner from the socket on the detector.	

Procedure	*Details*
20. Move the handle to the unlocked position to mechanically detach the transmission scanner from the detector. **Note**. The label on the AC Option bracket indicates the locked and unlocked position of the AC Option handle.	 Handle in unlocked position
21. Lift the transmission scanner free of the detector end.	

WARNING

Be careful when dismounting the transmission scanner from the detector. The transmission scanner weighs more than 40 lbs.

Procedure	*Details*
22. Locate the collision circuit jumper (part no. 9PLG1345) and install it on the connector behind the port on the detector cover. **Note**. The collision circuit jumper is only needed if the CardioMD system is to be used without the AC option. If the transmission scanners are just being removed for service purposes, you do not need to install the collision circuit jumper.	
23. Repeat steps 19 to 22 to dismount the transmission scanner on the other detector.	

WARNING

Make sure to handle the transmission scanners carefully. Do *not* drop a transmission scanner. Dropping a transmission scanner may cause injury or

damage the equipment.

If you drop a transmission scanner, you must alert the Radiation Safety Officer, who must follow the radiation regulations appropriate to the site to move the transmission scanner to a secure, shielded area, determine if it has been damaged, and assess possible radiation exposure.

12.5.1.2 Detaching the Line Source Compartment from the Bracket

To dismount the line source compartment from the bracket, proceed as follows:

Procedure	***Details***
1. Use a Torx T10 key to unscrew the four torx screws in each side.	
2. Carefully lift up the bracket and place it next to the line source compartment.	

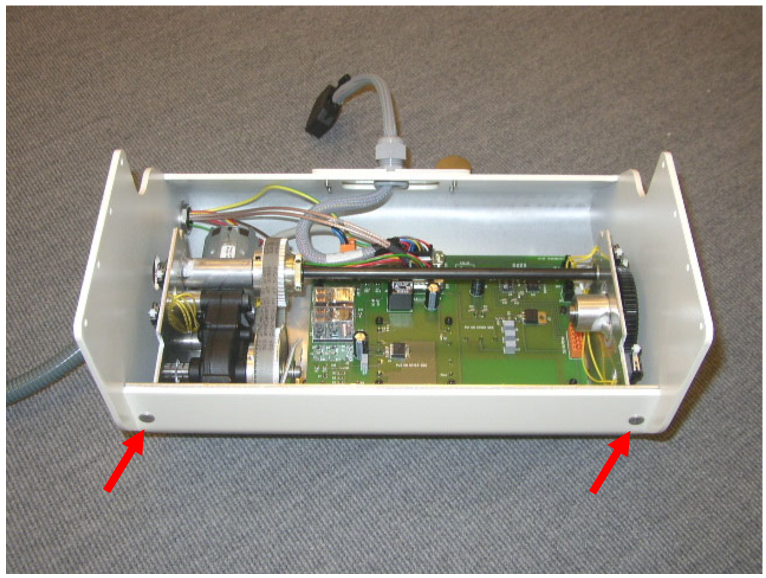
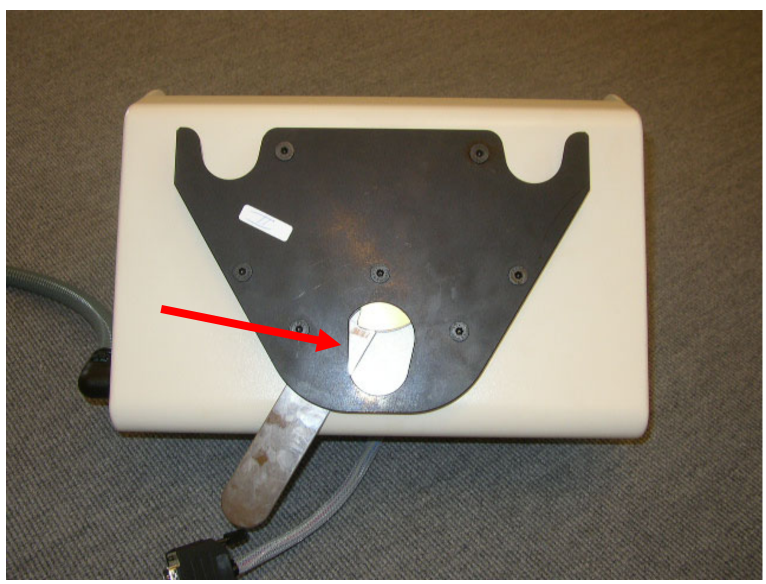
12.5.2 AC Option Bracket Repairs

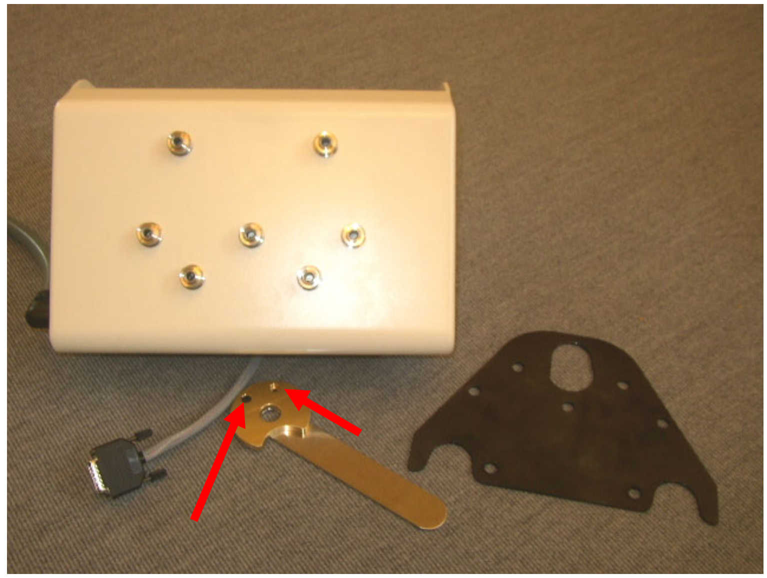
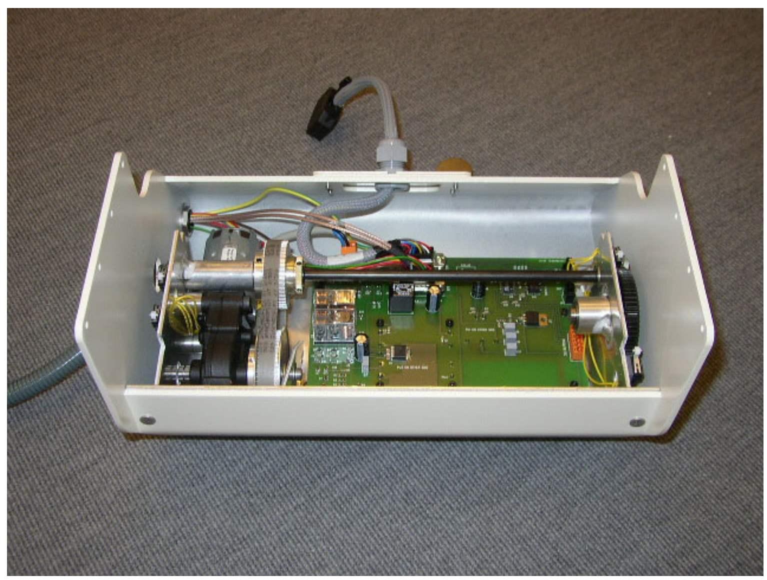
12.5.2.1 Dismounting Detector Cable

The 9CBL1357 cable connecting the bracket to the detector is easily replaced when the line source compartment has been dismounted from the bracket.

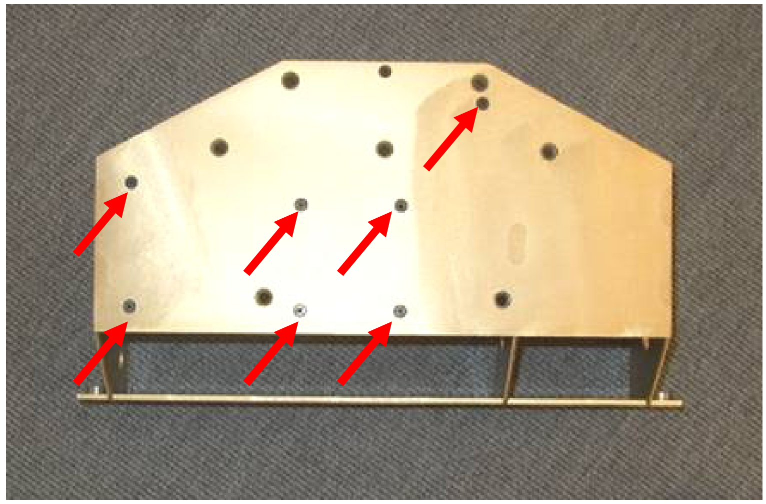
12.5.2.2 Disassembling the Bracket

To further disassemble the bracket for repairs, proceed as follows:

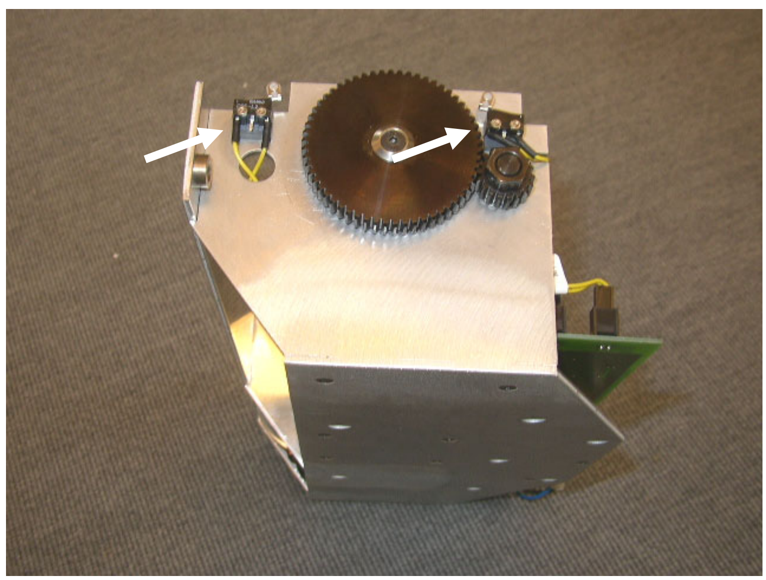
Procedure	*Details*
1. Use a Torx T20 key to unscrew the two torx screws in bottom side of the bracket.	
2. On the rear of the bracket, use a 4 mm Allen key to unscrew the 7 screws holding the steel mounting plate to the bracket. **Note**. Note the straight edge in the cutout next to the handle which is used to code the transmission scanner for detector 1 or detector 2. The photo shows coding for detector 2. The plate can be flipped to code the scanner for detector 1.	

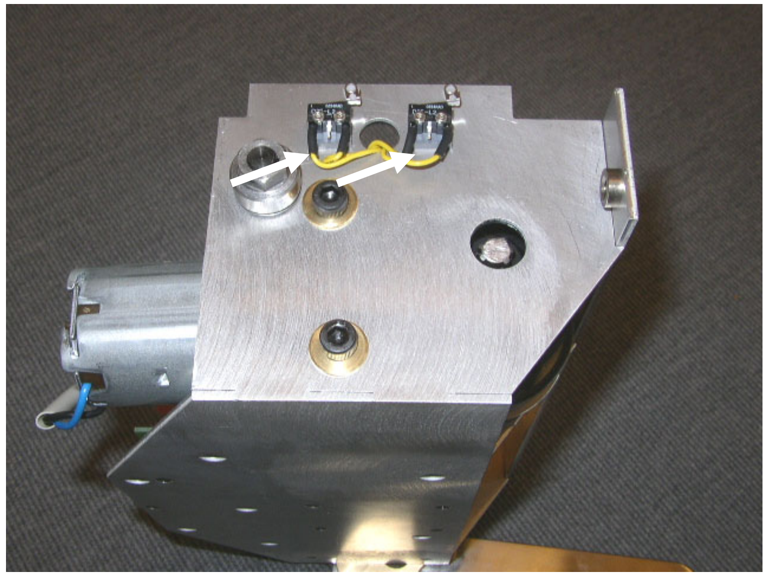
Procedure	*Details*
3. Remove the plate and the handle. **Note**. Note that the handle also forms part of the coding of the transmission scanner for detector 1 or detector 2. The handle shown in the photo is coded for detector 2. The handle can be mounted onto the brass disc using the other hole to code the handle for detector 1.	
4. Turn the bracket and unscrew the cable to the line source compartment and the cable to the detector. 5. Lift out the inner bracket assembly to access the bracket components.	

12.5.2.3 Replacing the Motor Power Board

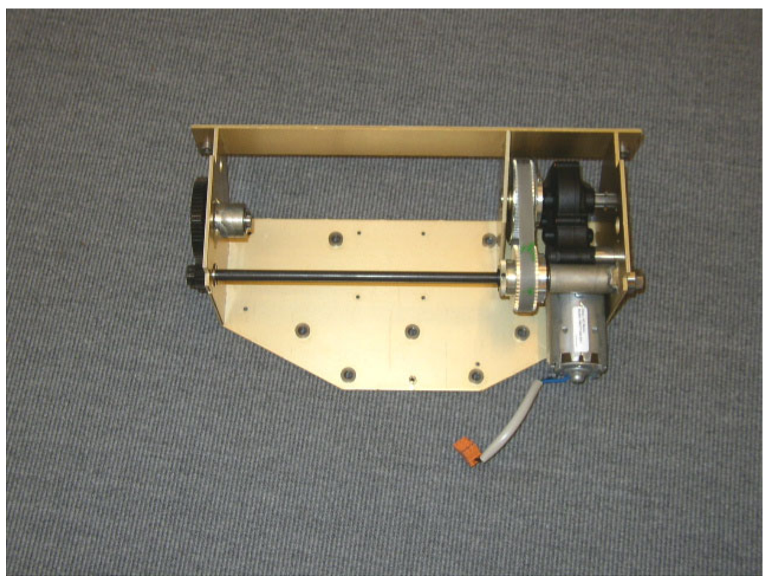
Procedure	*Details*
1. Unplug the detector and line source compartment cables.	
2. To remove the motor power board, unscrew the 7 screws from the rear of the inner bracket. Use a 2 mm Allen key.	

12.5.2.4 Replacing Limit Switches

Procedure	*Details*
1. Unplug the switches from motor power board. 2. Use a Torx T6 key to unscrew the limit switches from the motor and gear assembly. The photos on the right show the limit switches on both sides of the inner bracket assembly.	

Procedure	***Details***
	

12.5.2.5 Replacing the Motor and Gear Assembly

Procedure	***Details***
The photo on the right shows the motor and gear assembly 9ACO1429. See also section 12.7.1.2, page 12-110. 1. Follow the instructions given in the previous sections (section 12.5.2.3 and 12.5.2.4) to remove the motor power board and the limit switches from the motor and gear assembly. 2. Mount the motor power board and limit switches on the new motor and gear assembly.	

12.5.3 Line Source Compartment Repairs

12.5.3.1 Removing Line Source Compartment Covers

To access the parts inside the line source compartment, both covers must be removed. The following sections explain how to remove covers:

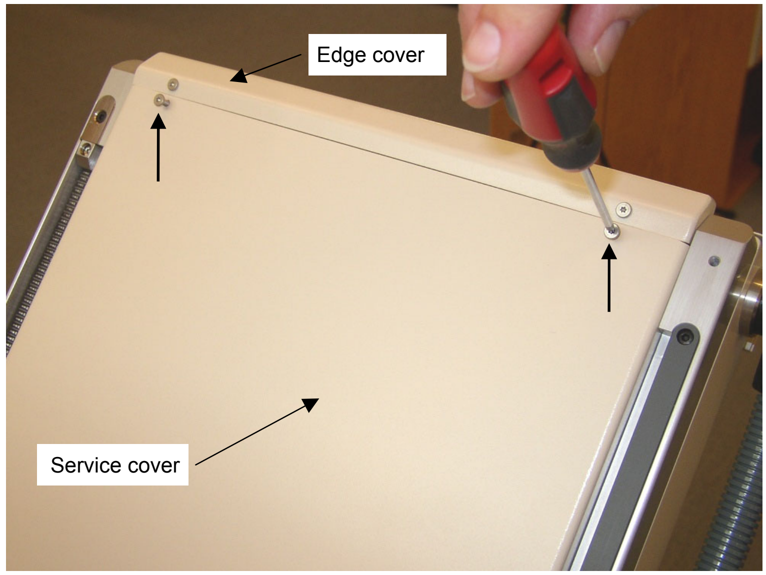
- While the transmission scanner is mounted on the detector, and
- When the transmission scanner is dismounted and the line source compartment has been detached from the AC option bracket.

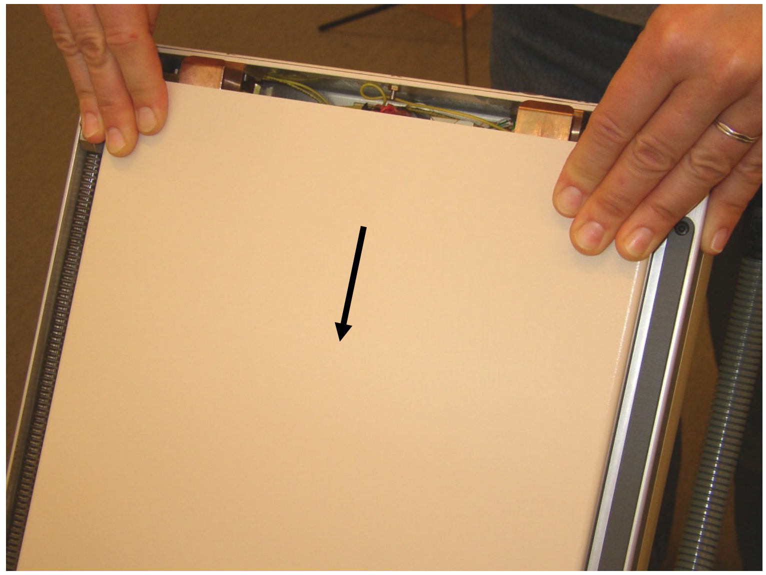
Transmission Scanner Mounted on Detector

Procedure	*Details*
1. Use the hand controller to position the detector assembly conveniently for access to the transmission scanner you are going to work with.	
2. If required, use the crank supplied with the CardioMD system to position the line source compartment conveniently.	

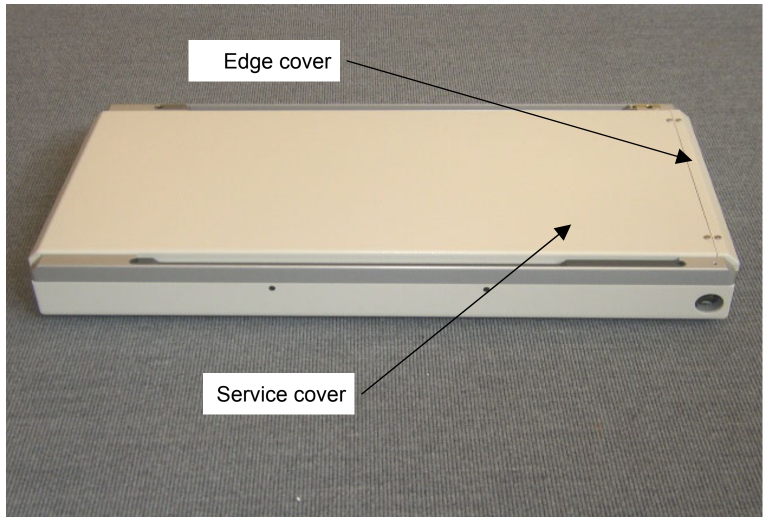
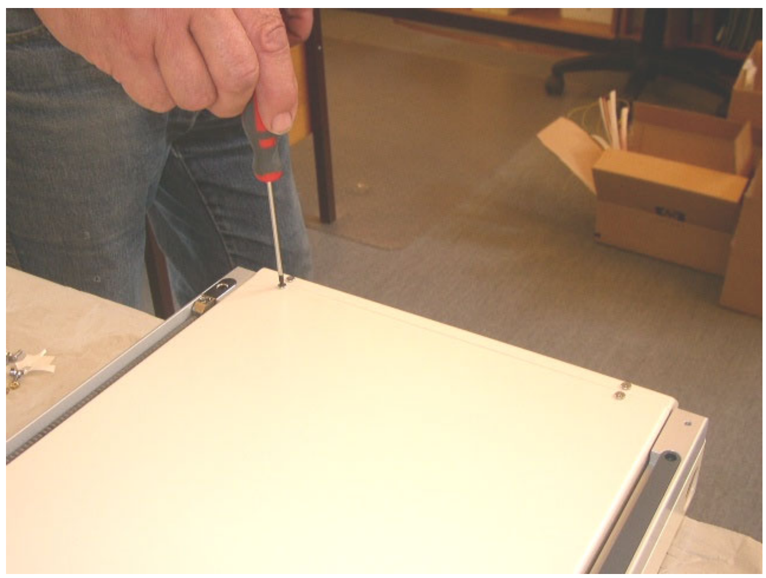
CAUTION

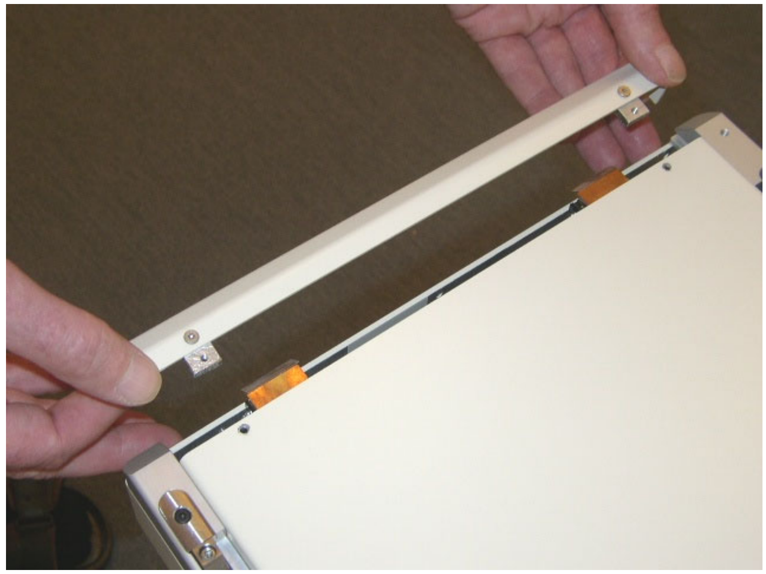
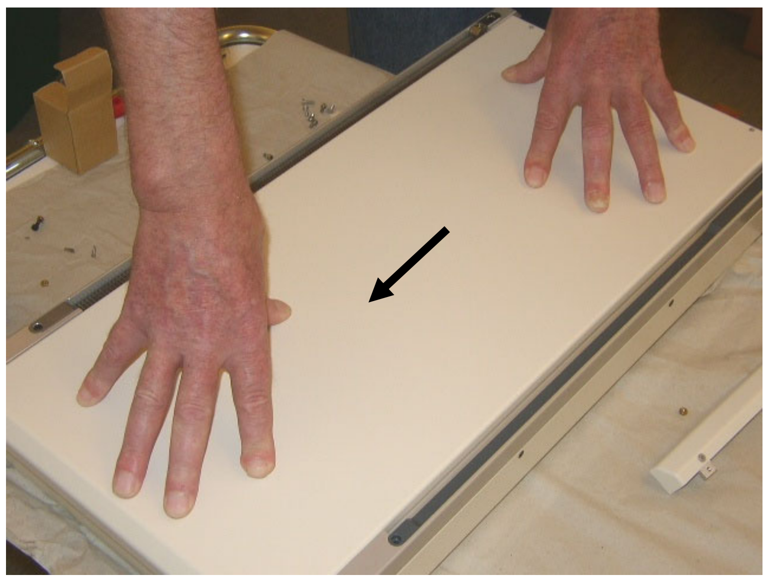
Caution. Make sure that all objects are clear of the detectors and transmission scanners before activating hand controlled motions.

Procedure	***Details***
3. Use a T09 Torx key to remove the two screws holding the service cover. **Note**. Leave the two screws in the edge cover in place.	
4. Slide out the edge cover.	

Procedure	***Details***
5. Press down the service cover as shown in the photo on the right and carefully slide out the cover in the direction of the arrow. **Note**. Hold on to the cover to avoid dropping it.	
6. Carefully slide out the service cover, while supporting it from below.	

Transmission Scanner Dismounted

Procedure	*Details*
The photo on the right shows the line source compartment detached from the AC option bracket.	
1. Use a T09 Torx key to remove the two screws holding the service cover. **Note**. Leave the two screws in the edge cover in place.	

Procedure	***Details***
2. Slide out the edge cover.	
3. Press down the service cover as shown in the photo on the right and carefully slide out the cover in the direction of the arrow.	

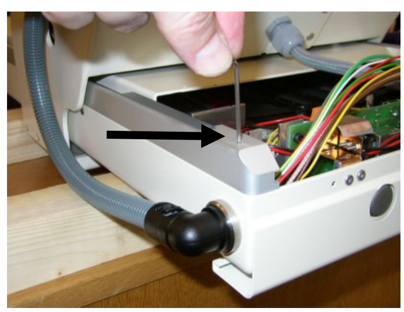
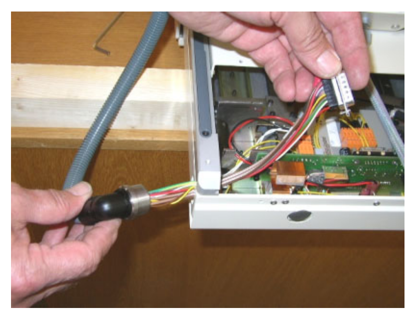
Procedure	*Details*
4. Lift up the end of the cover as shown and slide the cover all the way out.	

CAUTION

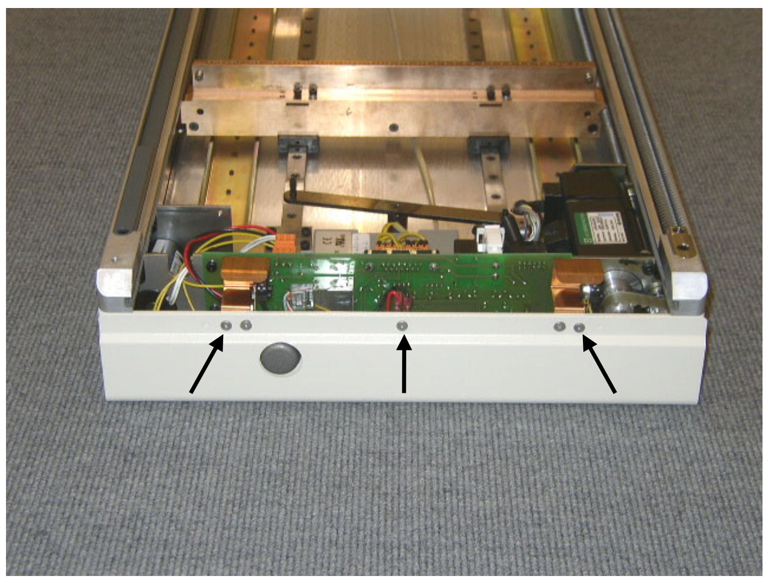
Caution. When remounting the service cover, it is very important to be cautious to avoid damaging the collision sensors under the cover. See section 12.5.3.10, page 12-77.

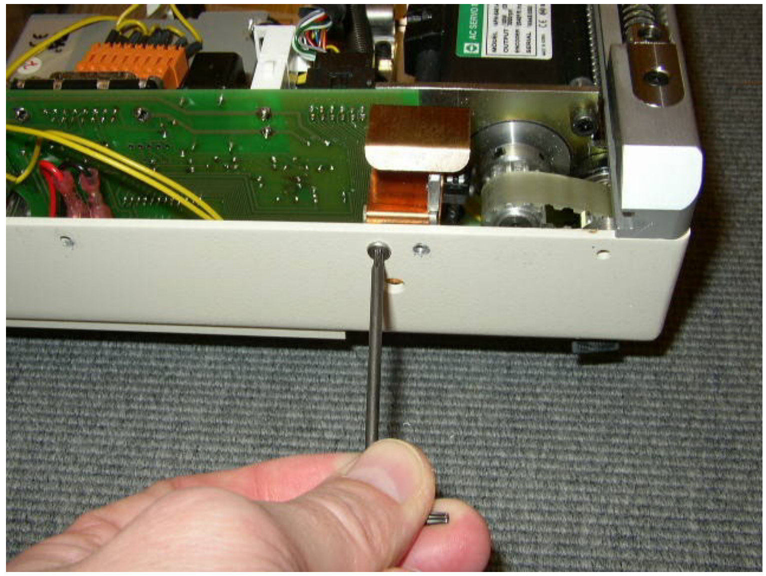
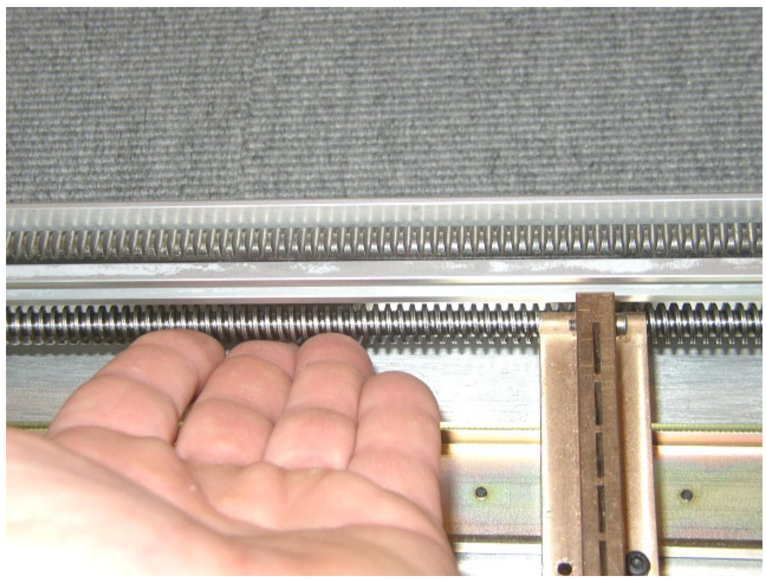
12.5.3.2 Dismounting Connecting Cable

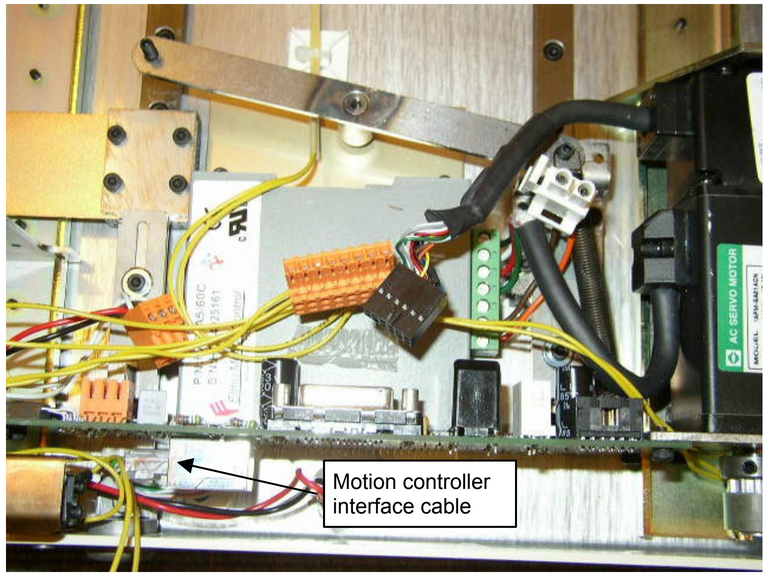
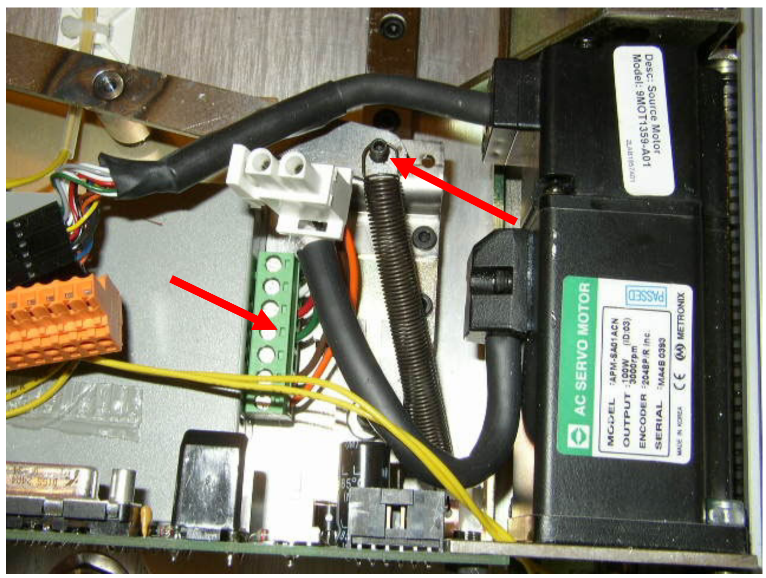
The 9CBL1344 cable connecting the bracket and the line source compartment can be replaced when the line source compartment has been dismounted from the bracket and the line source compartment covers have been removed.

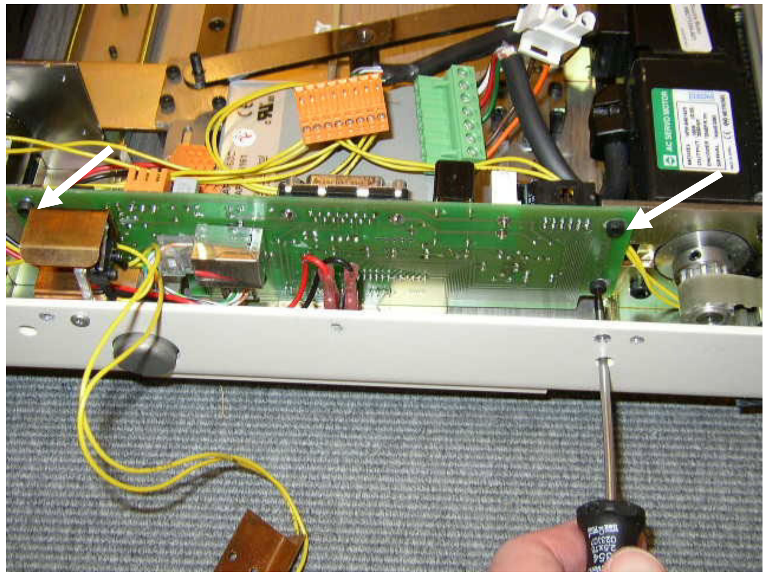
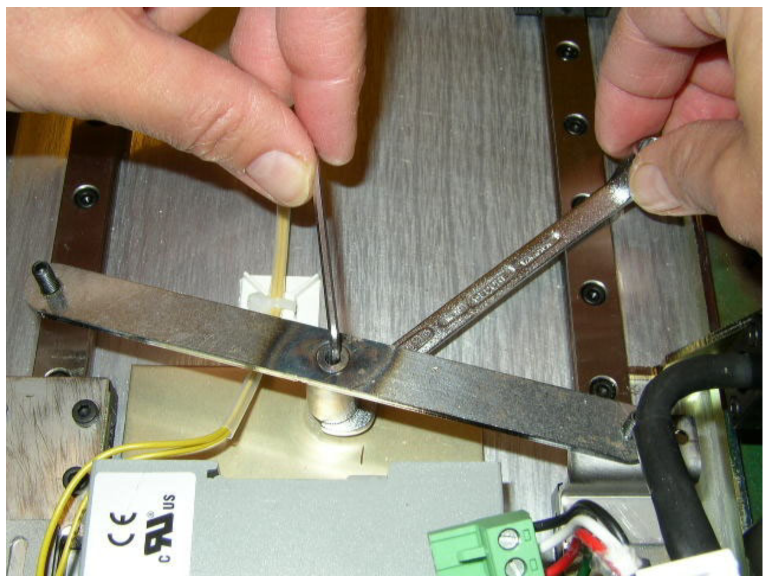
Procedure	*Details*
Note. The 9CBL1344 cable between the bracket and line source compartment is attached to the line source compartment by a set screw. 1. Remove the set screw through the small hole in the line source compartment indicated in the photos on the right.	 

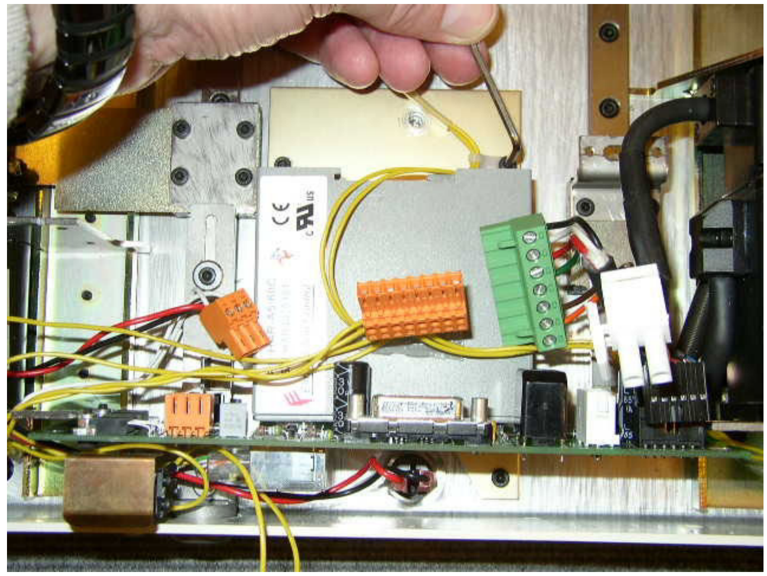
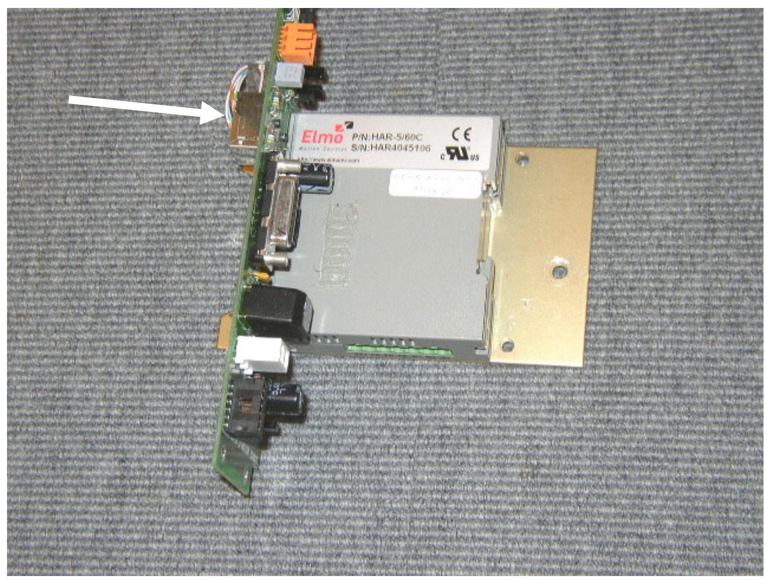
12.5.3.3 Replacing the AC Source Motion Board

Procedure	Details
Before starting to replace the AC source motion board: 1. Dismount the transmission scanner from the detector (see section 12.5.1.1, page 12-29). 2. Detach the line source compartment from the bracket (see section 12.5.1.2, page 12-33). 3. Remove line source compartment covers (see page 12-41). 4. Detach the connecting cable (see section 12.5.3.2, page 12-43).	
When all of the above steps have been performed, remove the collision detection shutter end cover: 5. Use a T08 Torx key to remove the 3 screws indicated in the photo on the right. 6. Remove the cover.	

Procedure	***Details***
7. Remove the collision sensor in front of the source motion board in the motor side of the line source compartment. This gives access to the screws holding the AC source motion board.	
8. If required, carefully turn the Acme screw to translate the line source housing to give room for further disassembly.	

Procedure	*Details*
9. Disconnect all cables from the source motion board, with the exception of the motion controller interface cable.	
10. Detach the spring from the line source position indicator arm. 11. Disconnect the connector from the motion controller.	

Procedure	***Details***
12. Remove the 4 Allen screws holding the source motion board.	
Now dismount the indicator arm: 13. Use a 7 mm fork wrench to loosen the jam nut and a 2 mm Allen key to unscrew the indicator arm.	

Procedure	***Details***
14. Use a 2.5 mm Allen key to remove the four screws holding the motion controller and AC source motion board assembly to the bottom of the line source compartment.	
15. Lift out the motion controller and AC source motion board assembly. 16. Disconnect the motion controller interface cable.	

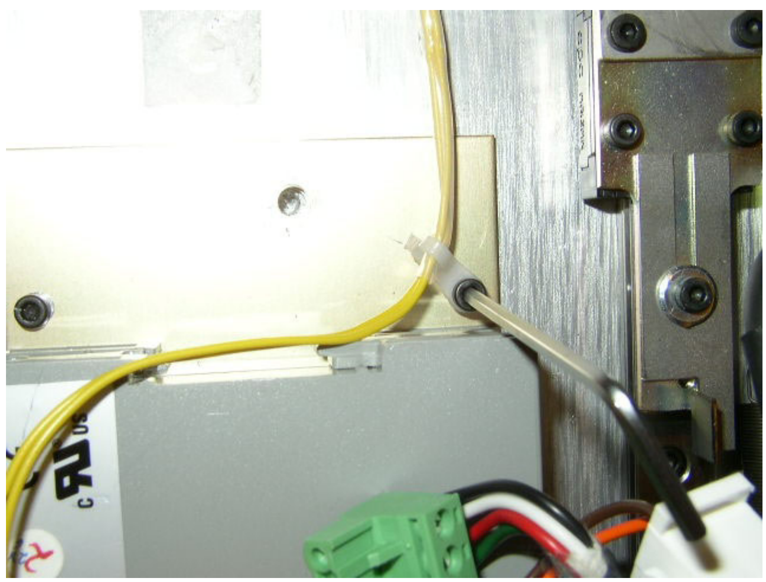
Procedure	***Details***

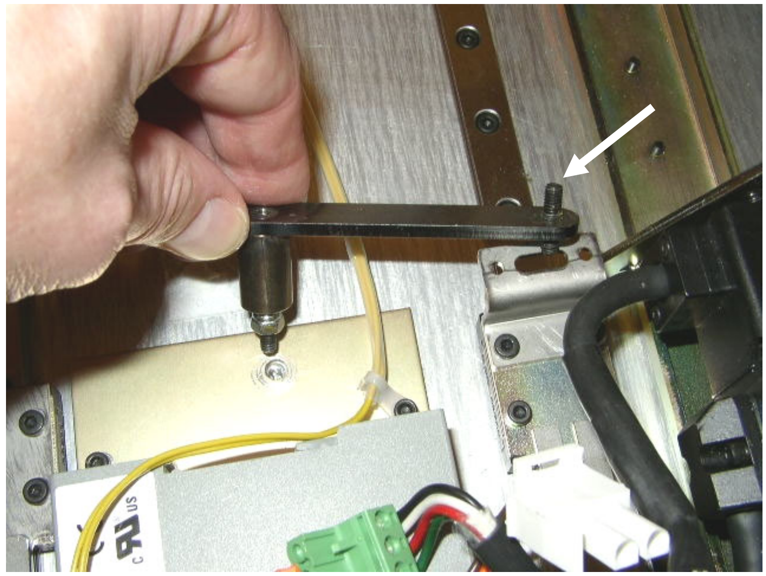
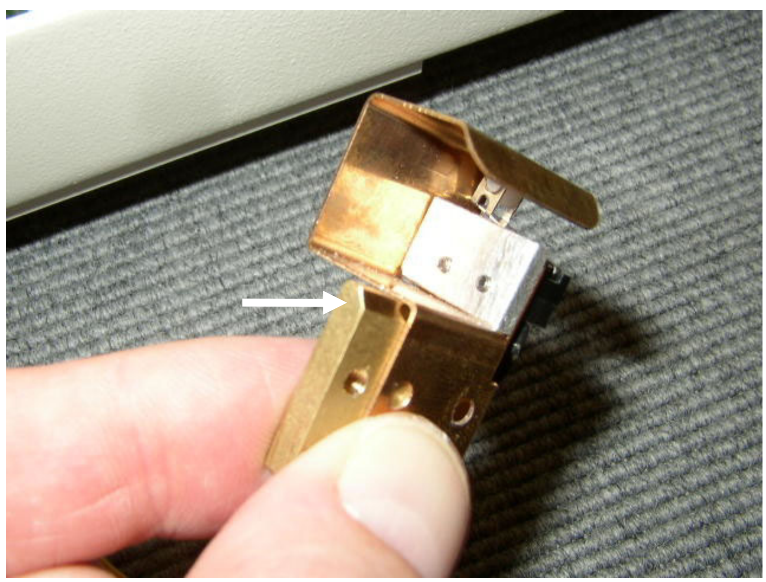
The source motion board can now be disconnected from the motion controller.

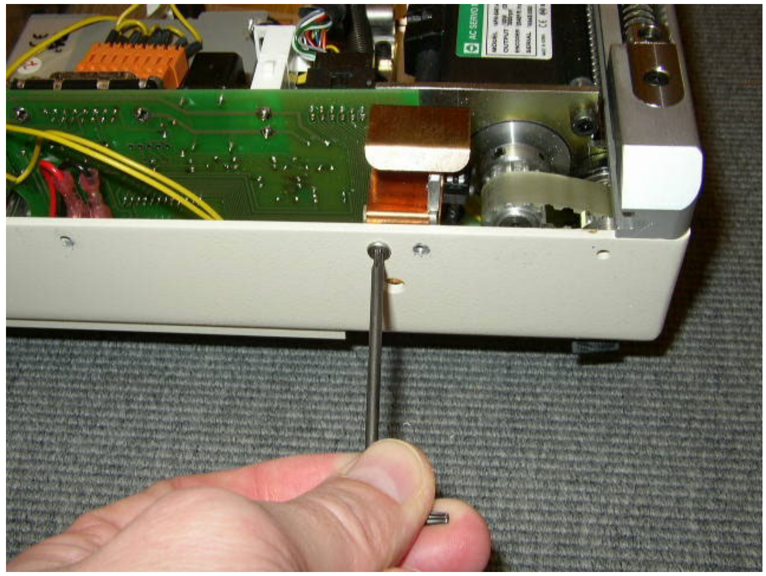
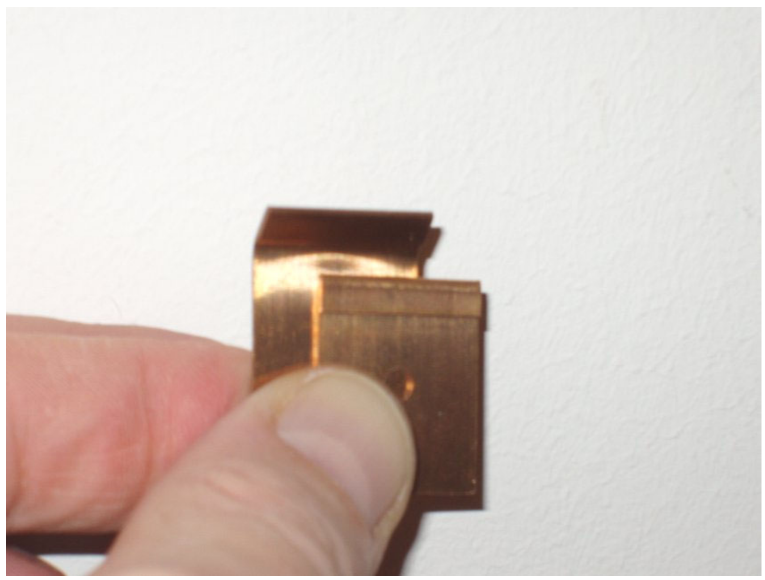
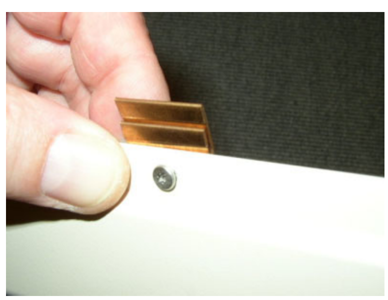
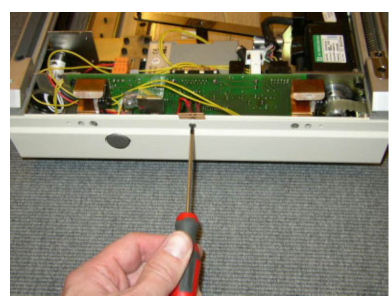
17. Assemble the new source motion board and the motion controller. Connect the motion controller interface cable.
18. Place the motion controller and AC source motion board assembly in the line source compartment.
19. Mount the four Allen screws holding the motion controller and AC source motion board assembly to the bottom of the line source compartment.
    Remember to include the cable tie holding the collision cable.

Note. The screw holding the cable tie is longer than the other screws and must be placed here.

20. Mount the four Allen screws holding the source motion board.



Procedure	*Details*
21. Install the line source position indicator arm, taking care to first fasten it to the slide on the right, as indicated by the arrow in the photo. 22. Use the 2 mm Allen key and the 7 mm fork wrench fasten the indicator arm and the jam nut.	
23. Attach the green connector to the motion controller. 24. Mount the spring onto the end of the indicator arm. 25. Connect all remaining cables to the source motion board.	
26. Assemble the collision sensor, paying attention to insert the bracket correctly. Note the orientation of the oblique edge in the photo on the right.	

Procedure	***Details***
27. Fasten the collision sensor to the end of the line source compartment, mounting one screw. See photo on the right.	
28. Assemble the spring and end stop as shown in the photo.	
29. Attach the spring and end stop to the collision detection shutter end cover. 30. Mount the collision detection shutter end cover onto the line source compartment. Remember to mount the nut on the inside of the line source compartment behind the spring and end stop. Proceed to remount covers, assemble the transmission scanner and install it on the detector: 31. Install the cable connecting the line source compartment to the bracket by reversing	 

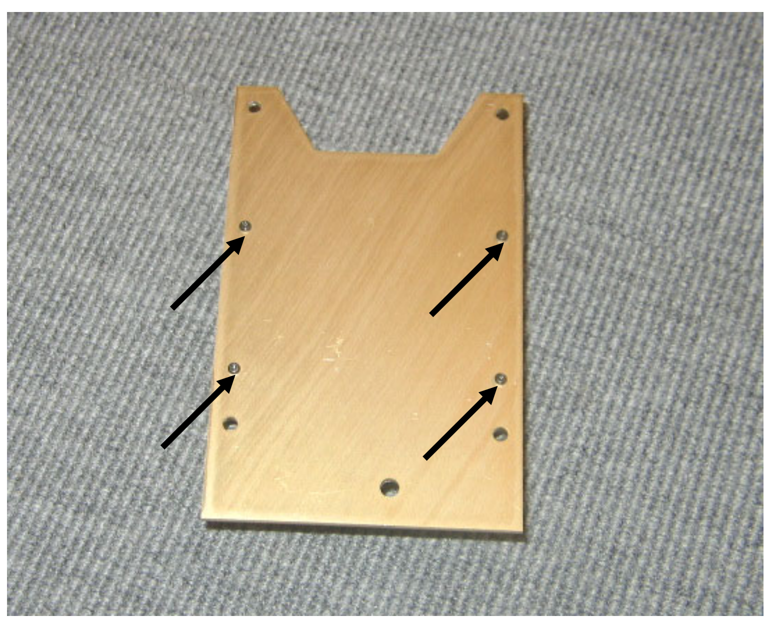
Procedure	*Details*
instructions provided in section 12.5.3.2, page 12-43.	
32. Install line source compartment covers (see page 12-79).	
33. Attach the line source compartment to the bracket by reversing instructions in section 12.5.1.2, page 12-33.	
34. Mount the transmission scanner onto the detector. See section 12.6.3.4, page 12-103.	

12.5.3.4 Replacing the Motion Controller

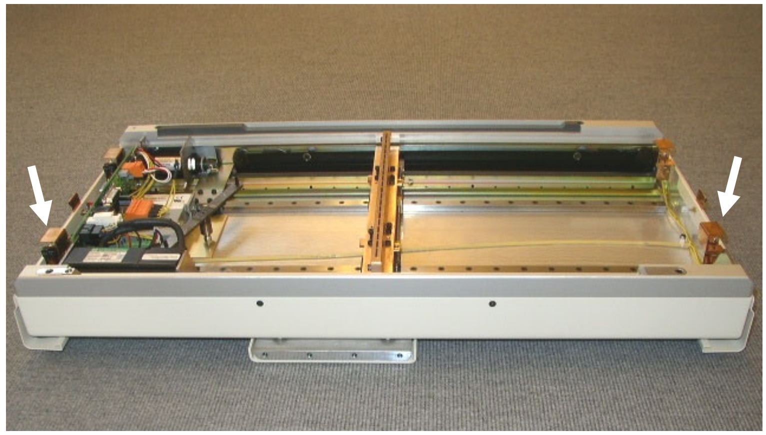
The hardware of the motion controllers of the two transmission scanners is identical but the motion controller firmware is different, according to whether the transmission scanner is for detector 1 or for detector 2. Thus, the motion controllers cannot be swapped.

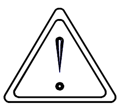
Note. Motion controller 9EMC1411 must be installed in transmission scanner 1 and motion controller 9EMC1410 must be in transmission scanner 2.

The procedure for replacing any of the two motion controllers is described below.

Procedure	*Details*
1. Follow the procedure for replacing the AC source motion board outlined in section 12.5.3.3 starting page 12-44 to dismount the motion controller and source motion board assembly.	
2. Use a T6 Torx key to unscrew the motion controller from its mounting plate.	
The arrows in the photo on the right indicate the position of the screws.	
3. Follow instructions in section 12.5.3.3 to reassemble and mount the transmission scanner.	

12.5.3.5 Replacing the AC Option Servo Motor

Procedure	*Details*
1. Use a T08 Torx key to remove the two collision sensors above the motor Acme screw assembly. The arrows in the photo indicate the collision sensors to be removed.	
2. Follow the procedure given in the section *Removing the Line Source Housing*, page 12-68 to remove the line source housing.	

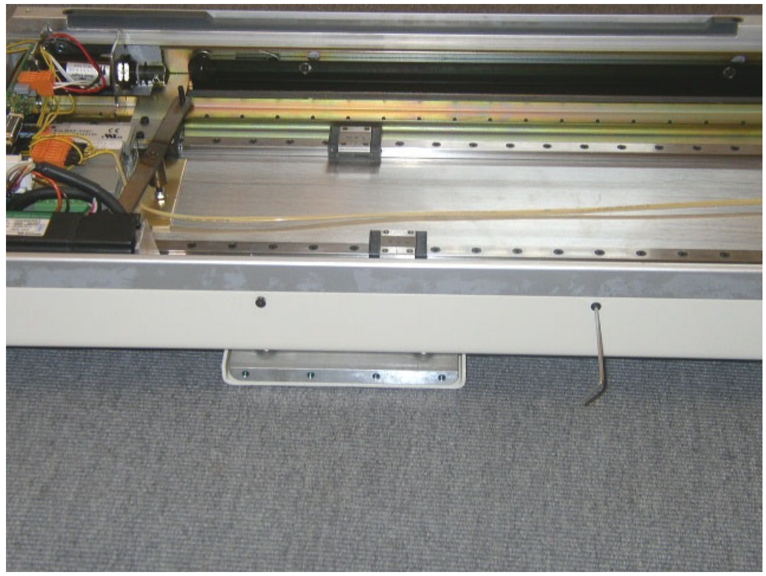
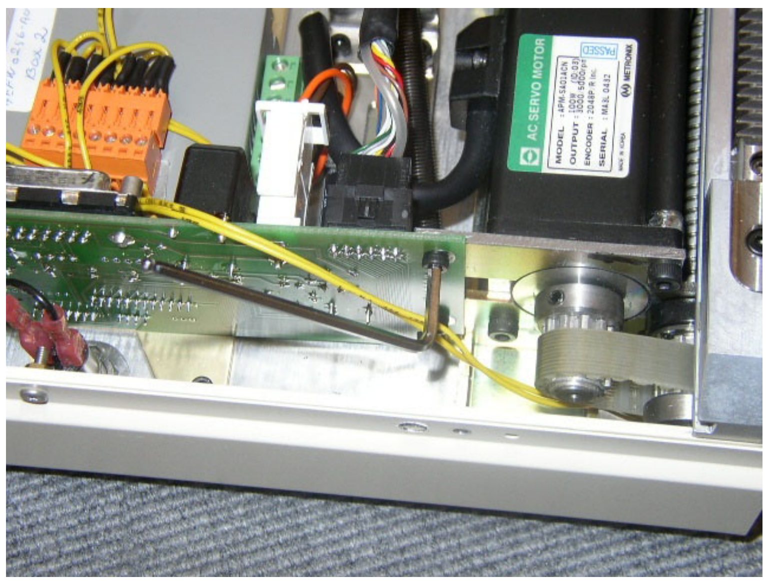


WARNING

Make sure that the transportation screws are in place and locking the shutter before attempting to remove the source holder. Failing to lock the shutter may cause you to be exposed to radiation from the source inside the holder.

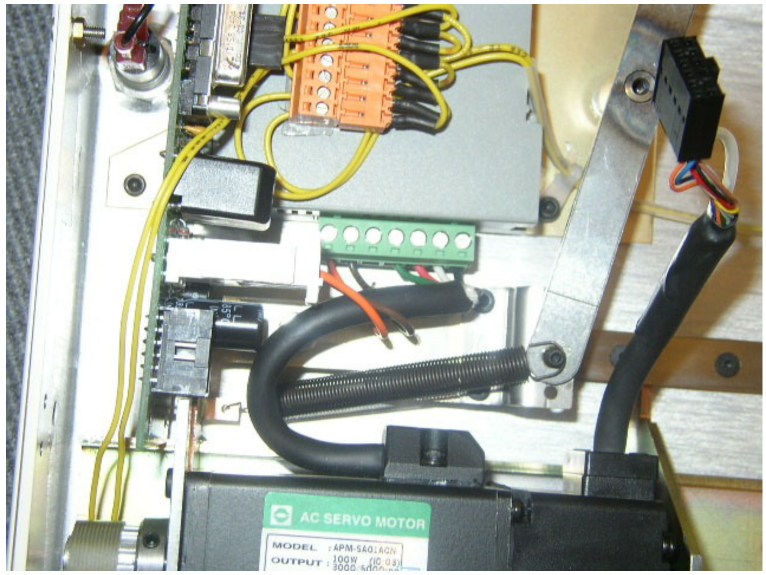
Due to the Gd-153 source, the CardioMD line source housings contain significantly higher levels of radiation than normally used in clinical imaging. Potential for radiation exposure exists. Use good radiation safety practices.

Handling of line source housings with Gd-153 sources installed shall only be performed by Philips Nuclear Medicine employees that have had radiation safety training classes and trained on proper handling of radioactive material.

Procedure	***Details***
3. Use a 2 mm Allen key to loosen the side rail from the line source compartment.	
4. Use 2.5 mm Allen key to loosen the AC source motion board from the bracket supporting the motor and ball screw.	

Procedure	***Details***

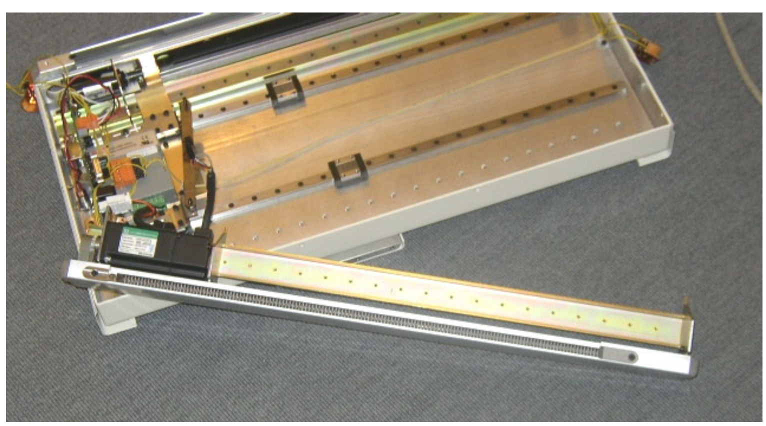
5. Unscrew the motor cable connections from the motion controller connector:
   Green to pin 4 (PE)
   Red to pin 5 (M1)
   White to pin 6 (M2)
   Black to pin 7 (M3).
6. Disconnect the spring from the motor and Acme screw bracket.

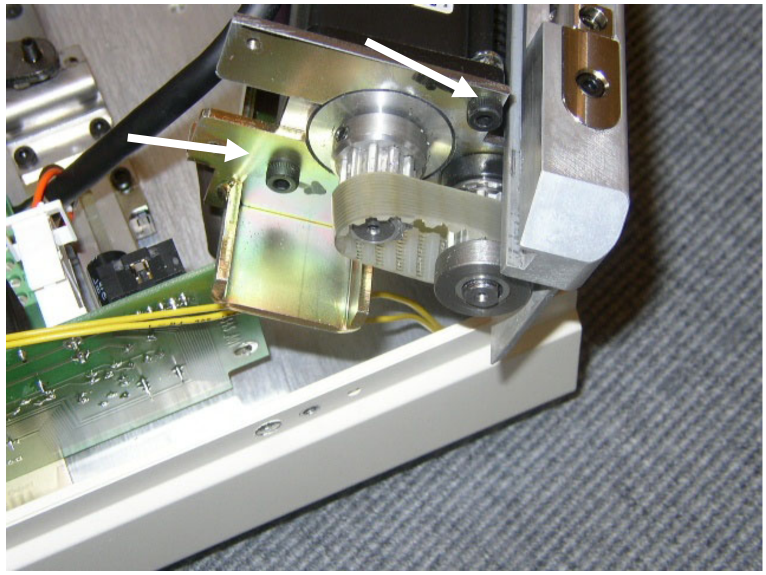


7. Use a 2.5 mm Allen key to unscrew the rail on the underside of the line source compartment.

This will loosen the bracket holding the motor and ball screw.

8. Carefully lift up the bracket and side panel assembly.



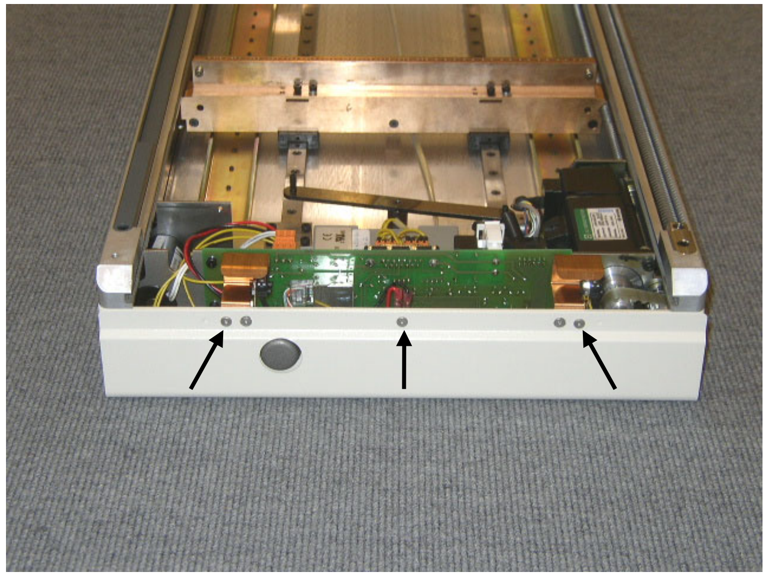
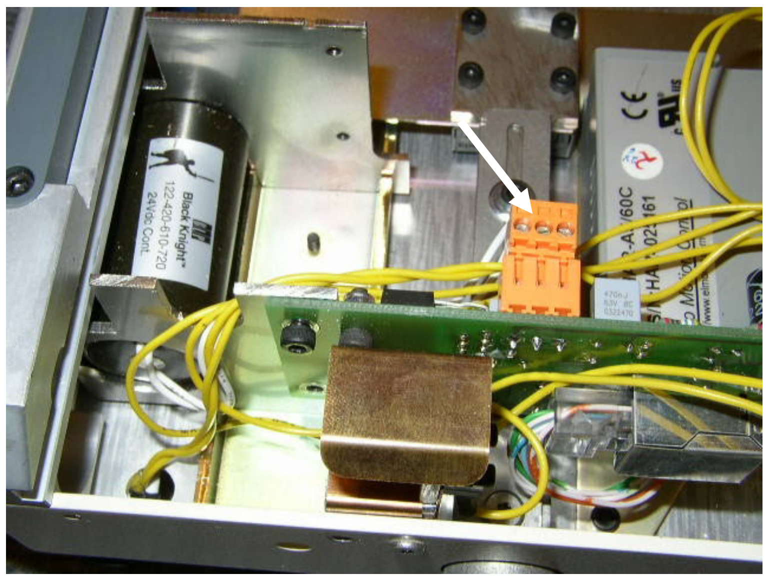
Procedure	*Details*
9. Remove the belt from the motor shaft. The motor can now be removed: 10. Use a 3 mm Allen key to unscrew the two screws holding the motor.	
11. Install the new motor by reversing steps 1 to 10.	

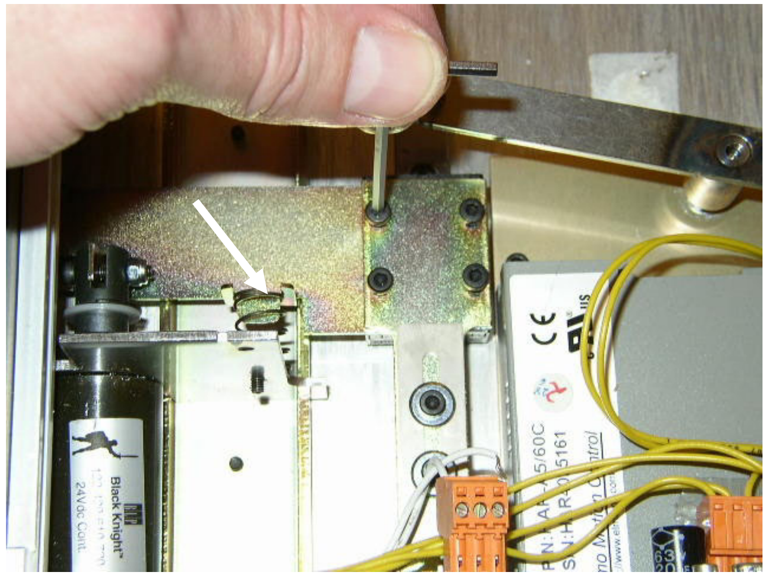
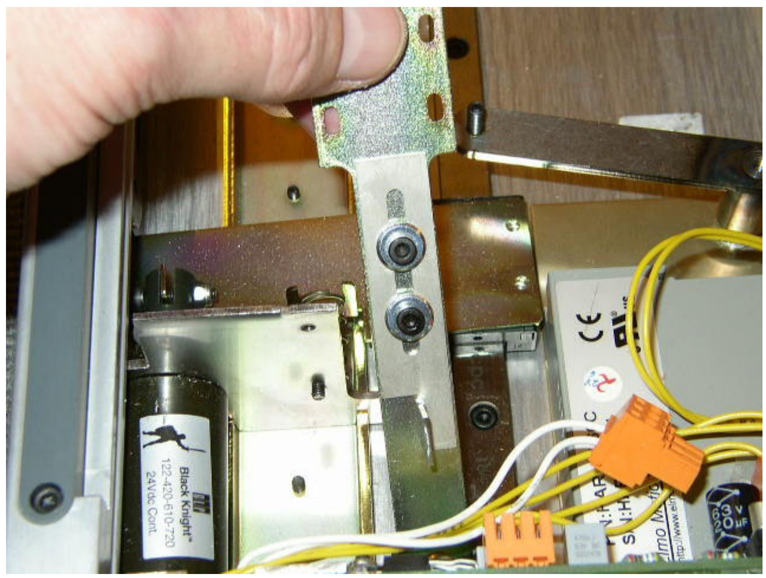
Note. When reassembling the line source compartment, route the encoder cable carefully to prevent interference with the line source position indicator arm (see Figure 12.14 on page 12-17).

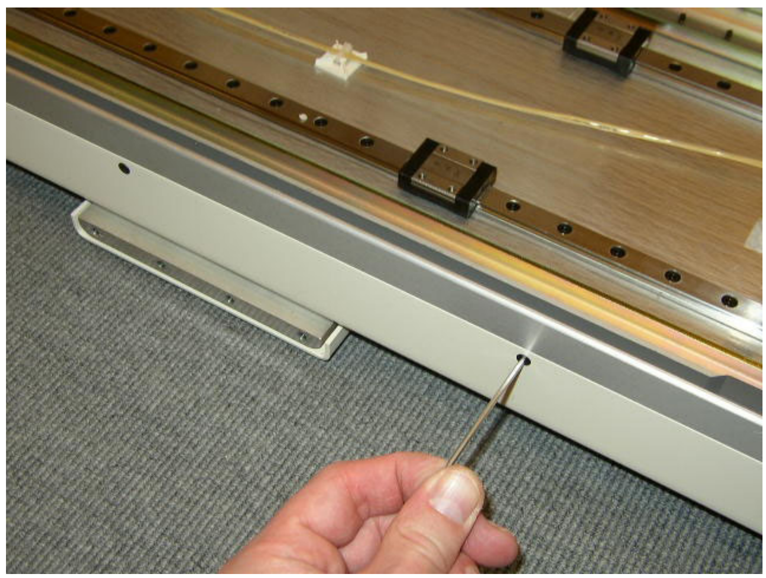
12.5.3.6 Replacing the Solenoid

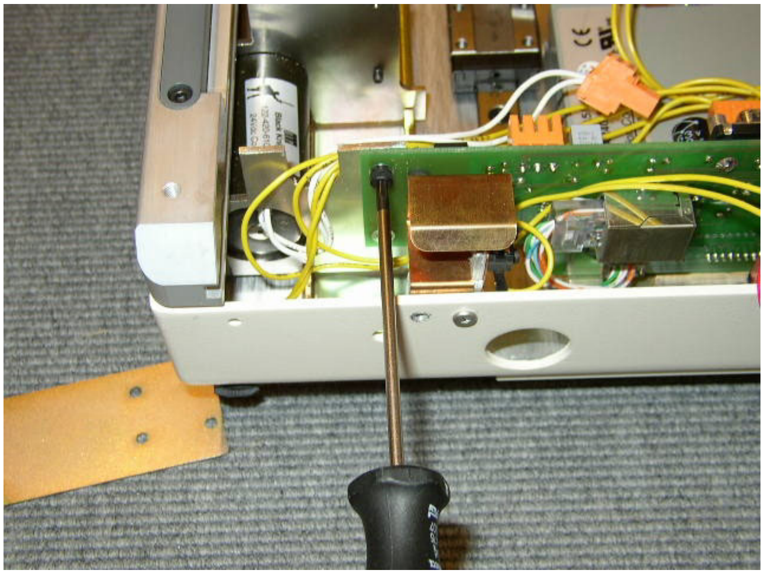
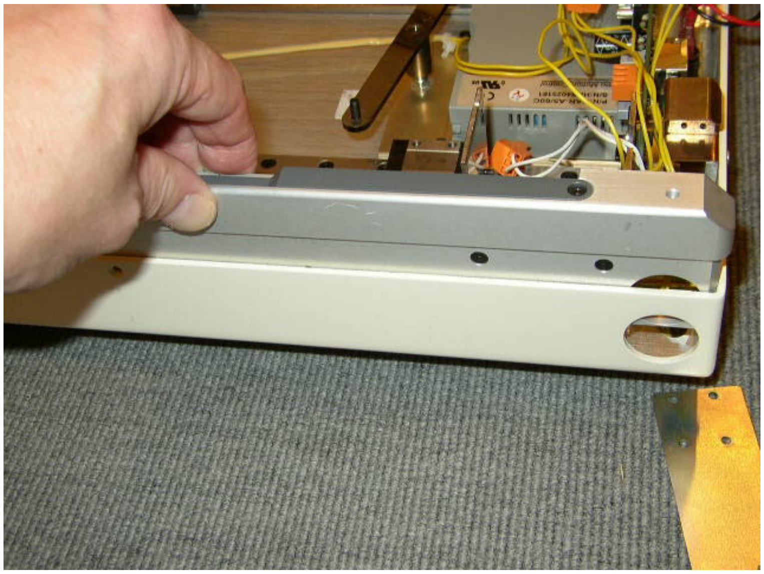
The procedure for replacing the solenoid is analogous to exchanging the AC servo motor. You perform similar steps but working in the other side of the line source compartment.

Procedure	*Details*
Prepare for replacing the solenoid as follows: 1. Dismount the transmission scanner from the detector (see section 12.5.1.1, page 12-29). 2. Detach the line source compartment from the bracket (see section 12.5.1.2, page 12-33). 3. Remove line source compartment covers (see page 12-41). 4. Detach the connecting cable (see section 12.5.3.2, page 12-43).	

Procedure	***Details***
When all of the above steps have been performed, remove the collision detection shutter end cover: 5. Use a T08 Torx key to remove the 3 screws indicated in the photo on the right. 6. Remove the cover.	
7. Disconnect the solenoid connector from the AC source motion board.	

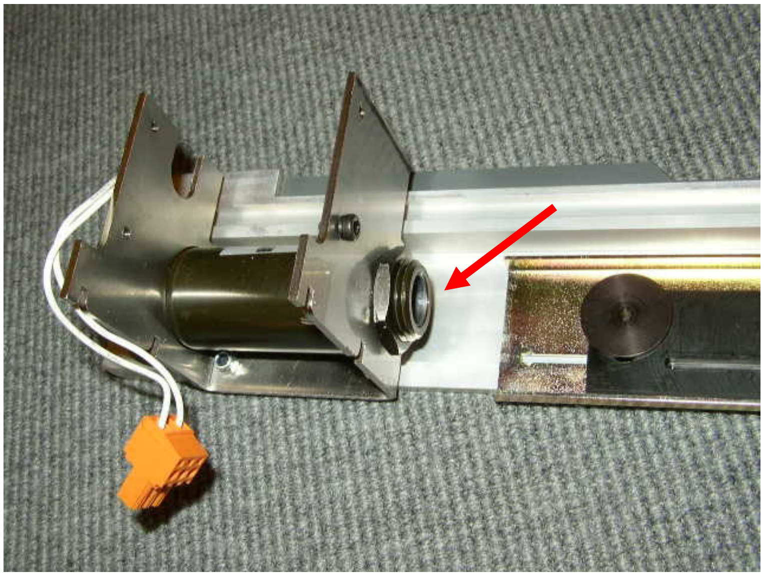
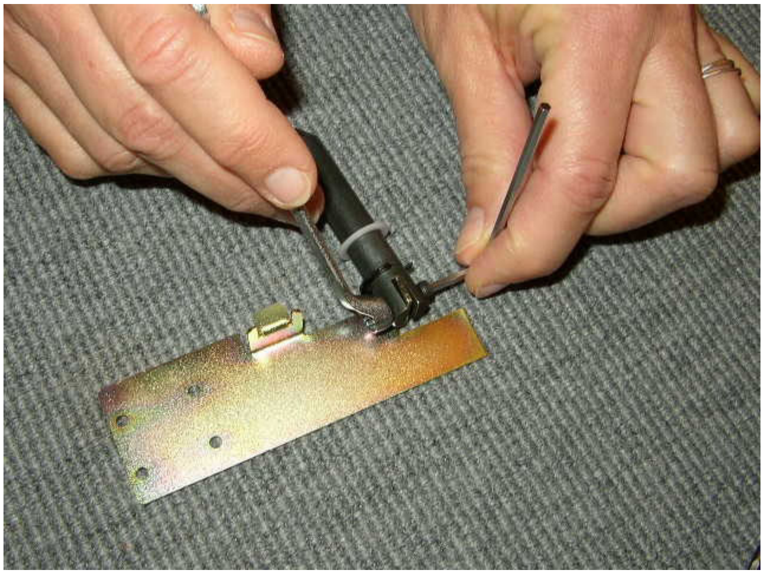
Procedure	***Details***
8. Use a 2.5 mm Allen key to remove the four screws holding the shutter indicator / manual lever to the slide bearing. **Note**. Mind the spring holding the actuator bracket.	
9. Remove the shutter indicator / manual lever.	

Procedure	***Details***
10. Remove the actuator bracket and spring.	
11. Use a 2 mm Allen key to loosen the two screws holding the side rail to the line source compartment.	

Procedure	*Details*
12. Remove the two Allen screws in the side of the source motion board towards the solenoid.	
13. Lift up and remove the side rail from the line source compartment.	

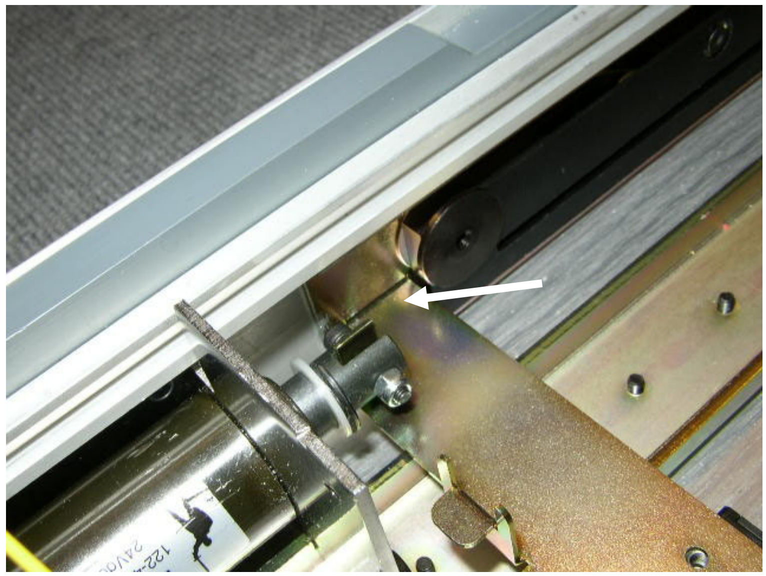
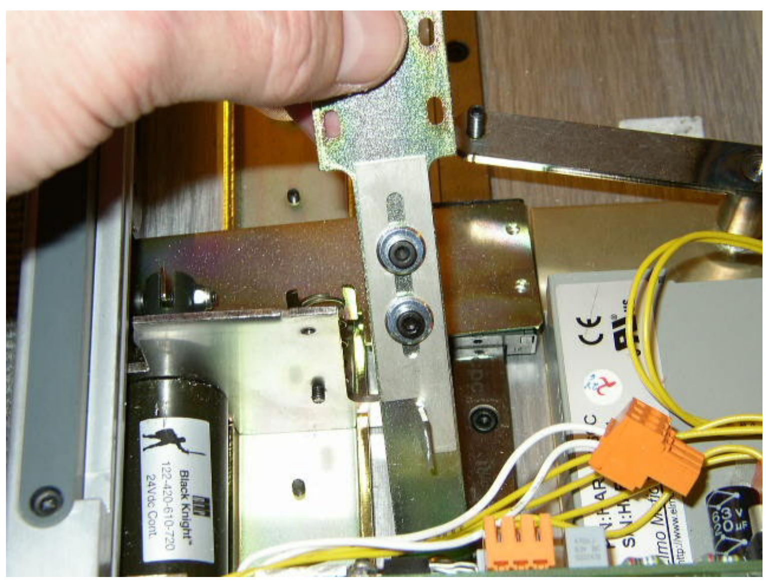
CAUTION

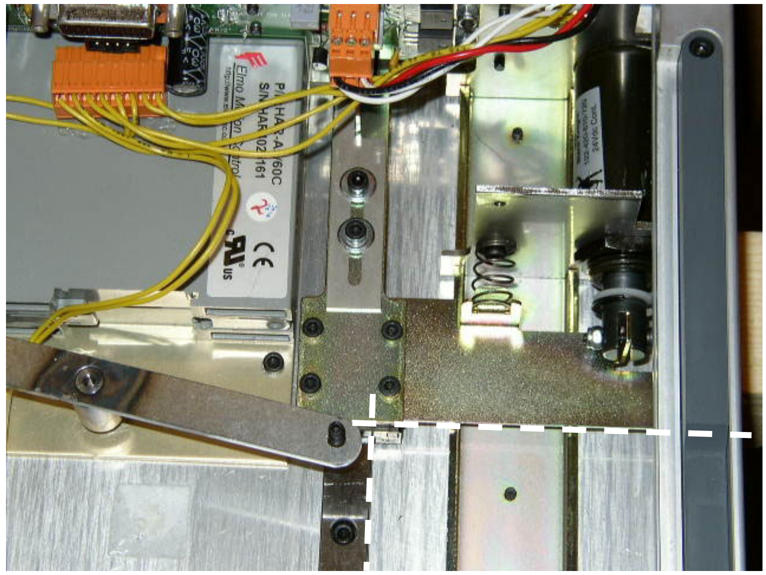
Caution. When removing the side rail, take care not to damage the source motion board.

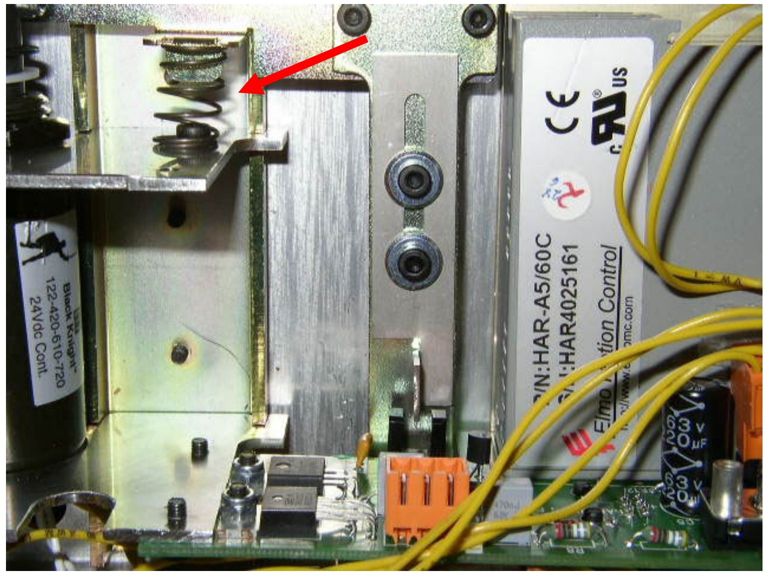
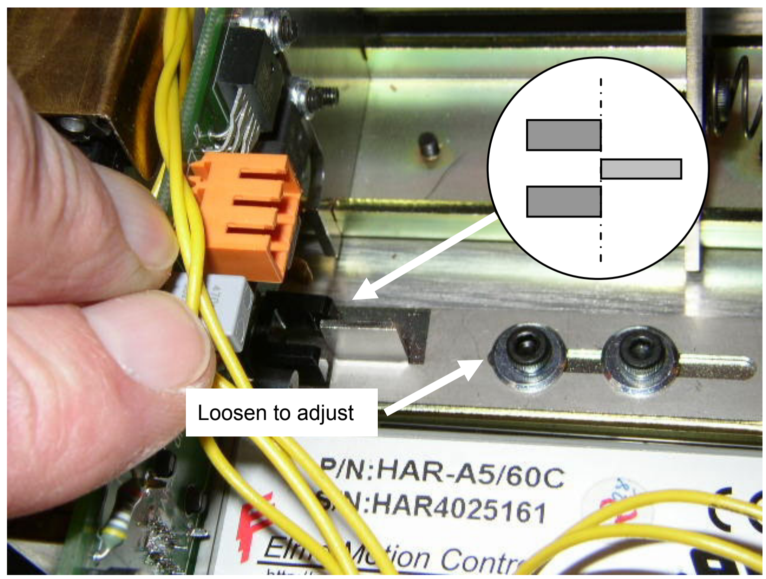
Procedure	***Details***
14. Loosen the 22 mm nut holding the solenoid. 15. Replace the solenoid, and mount the 22 mm nut.	
16. Loosen the nut and bolt holding the anchor to the bracket. 17. Replace the anchor. **Note**. Do *not* tighten the nut and bolt holding the anchor. It is important that the anchor is held quite loosely to the bracket. **Note**. It is important that the anchor is replaced along with the solenoid.	
18. Mount the side rail onto the line source compartment.	

CAUTION

Caution. When mounting the side rail, take care not to damage the source motion board.

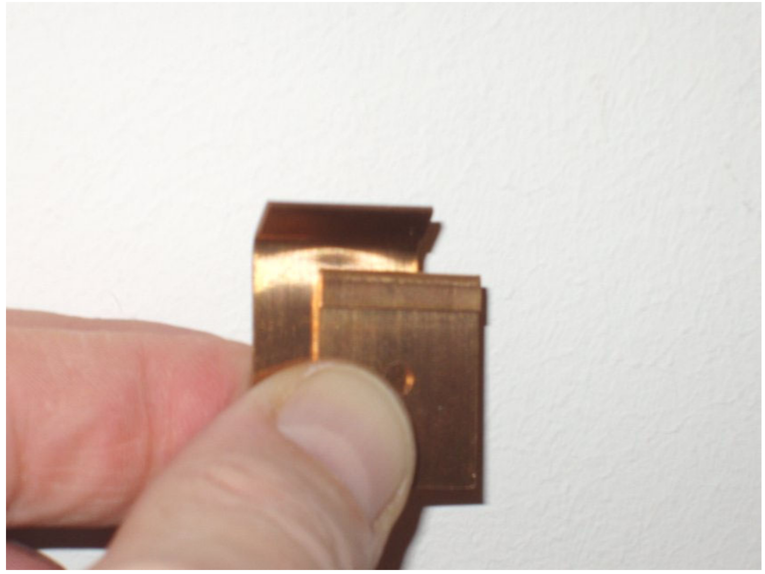
Procedure	***Details***
19. Mount the two Allen screws holding the side rail to the compartment.	
20. Mount the two Allen screws holding the source motion board.	
Note. It is important to fasten the side rail before mounting the Allen screws in the source motion board.	
21. Mount the actuator bracket, inserting the anchor into the solenoid. **Note**. Make sure that the end of the bracket fits into the groove in the side of the line source compartment.	
22. Re-insert the shutter indicator / manual lever.	
23. Mount the four Allen screws holding the indicator and the actuator bracket to the slide bearing.	
Note. Do *not* tighten the Allen screws yet.	

Procedure	***Details***
At this point, it is necessary to adjust the entire assembly in order for the shutter indicator / manual lever to be able to move smoothly. 24. Check that the edge of the actuator bracket is perpendicular to the slide rail in the bottom of the line source compartment.	
25. Check that the shutter indicator / manual lever moves unhindered through the opening in the line source compartment. 26. Tighten the four Allen screws holding the shutter indicator / manual lever.	

Procedure	*Details*
27. Mount the spring onto the actuator bracket.	
28. Check the alignment of optocoupler detecting the position of the shutter indicator / manual lever. When the shutter is in the closed position (shutter indicator / manual lever in the IN position), the position must be as indicated on the photo. 29. If required, the position of shutter indicator / manual lever can be adjusted by loosening the two Allen screws shown.	
30. Finally, operate the manual lever a few times and check that it is still moving smoothly. 31. Reconnect the solenoid cable.	

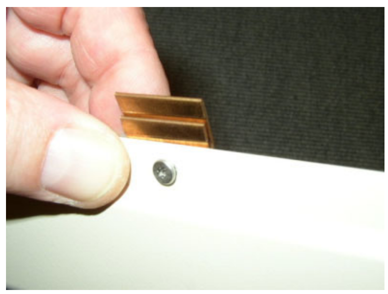
Procedure	***Details***

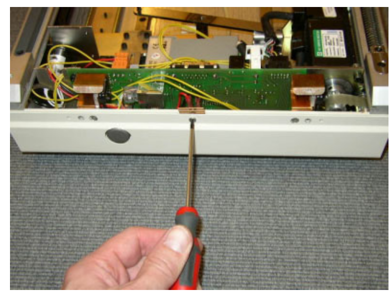
32. Assemble the spring and end stop as shown in the photo.



33. Attach the spring and end stop to the collision detection shutter end cover.
34. Mount the collision detection shutter end cover onto the line source compartment.

Remember to mount the nut on the inside of the line source compartment behind the spring and end stop.



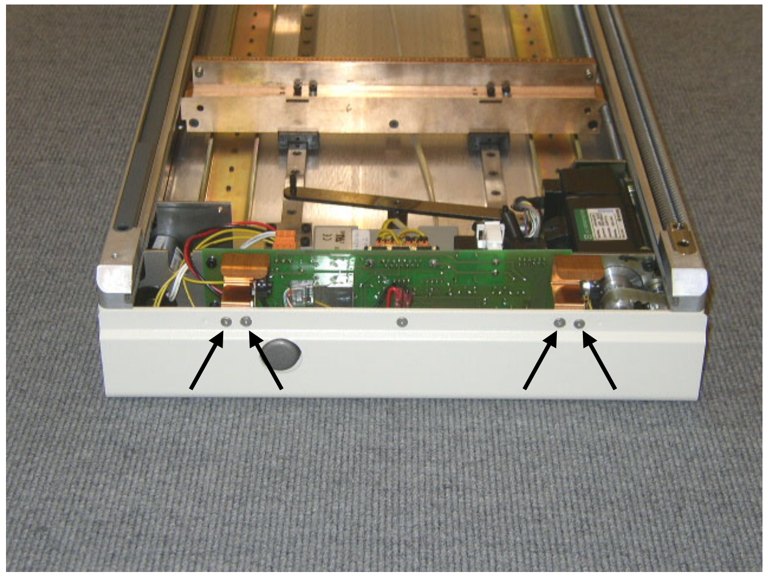
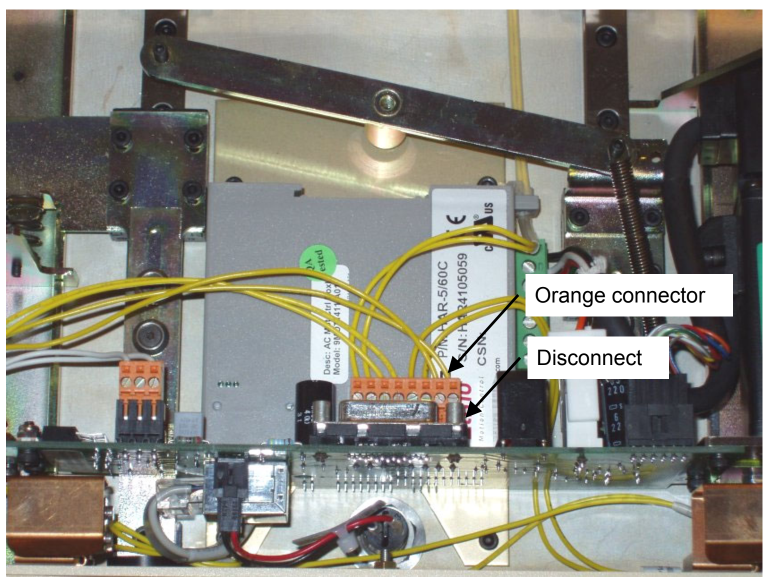


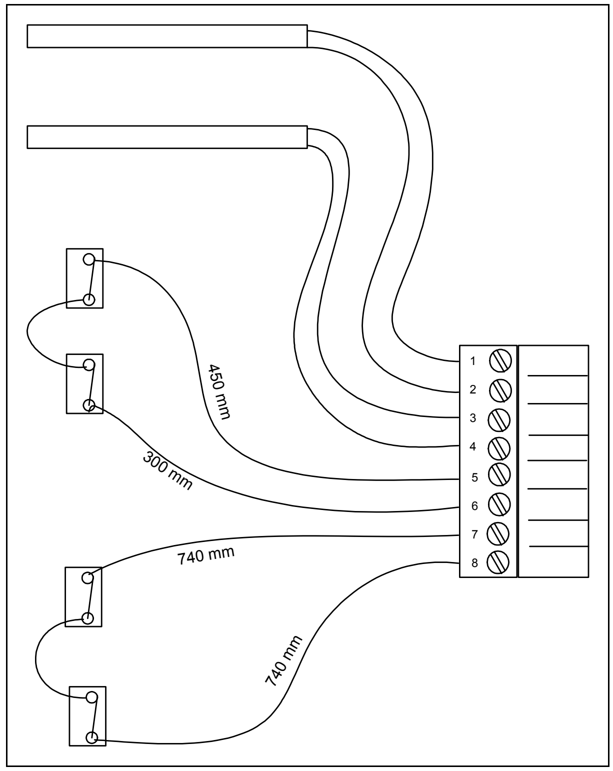
Proceed to remount covers, assemble the transmission scanner and install it on the detector:

35. Install the cable connecting the line source compartment to the bracket by reversing instructions provided in section 12.5.3.2, page 12-43.
36. Install line source compartment covers (see page 12-79).
37. Attach the line source compartment to the bracket by reversing instructions in section 12.5.1.2, page 12-33.
38. Mount the transmission scanner onto the detector. See section 12.6.3.4, page 12-103.

12.5.3.7 Replacing Collision Sensors

Collision sensors for the line source compartment are provided in pairs (assemblies). One assembly, the longer one, is located furthest away from the motor. The shorter assembly is located at the motor end of the line source compartment. The procedure for replacing both assemblies is the same.

Procedure	*Details*
1. Use a T08 Torx key to unscrew the two collision sensors from the line source compartment.	
2. Locate the orange connector on top of the motion controller. 3. Unplug the connection to the AC source motion board.	

Procedure	***Details***
4. Unscrew the two wires from the collision sensors to be replaced. The connector pinout is shown to the right.	

5. Mount the new set of collision sensors by reversing the steps 1 to 4.

Note. Sensors *must* be mounted square and flush so that they mate with the cover surface evenly across their surface.

12.5.3.8 Exchanging Line Sources

The line sources of the AC option must be replaced approximately every two years.

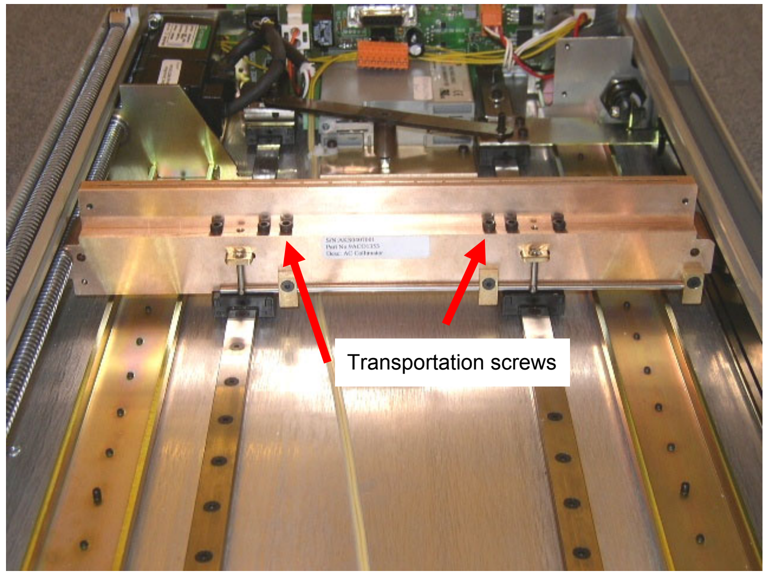
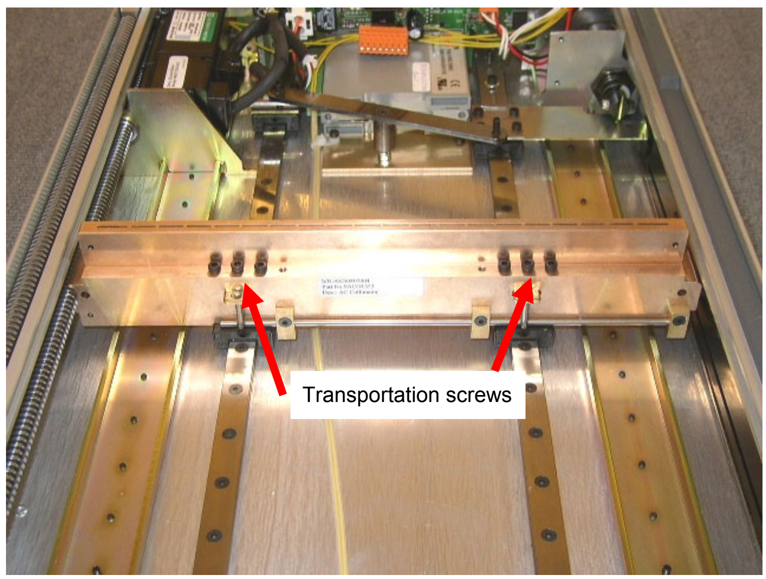
WARNING

When exchanging line sources, do *not* open the line source housing to remove the line source. The entire line source housing must be returned to the manufacturer for exchange of the source.

Removing the Line Source Housing

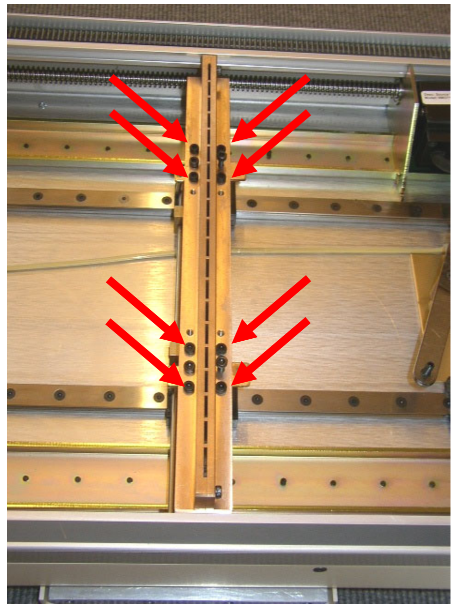
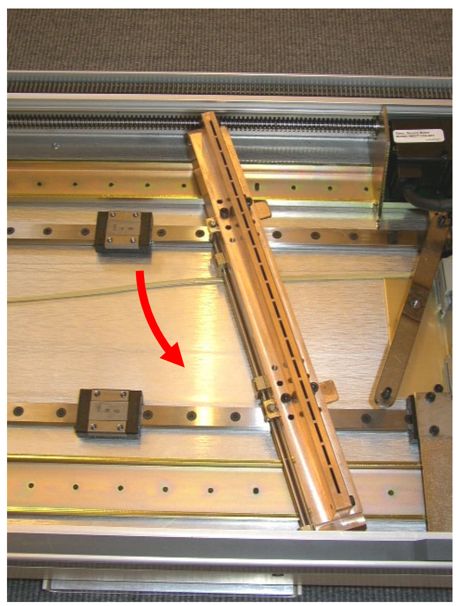
Before the line source housing can be removed from inside the line source compartment, you must dismount the transmission scanner from the detector, detach the line source compartment from the AC option bracket and remove the covers of the line source compartment. Proceed as follows:

Procedure	***Details***
1. Remove the transmission scanner from the detector.	
See section 12.5.1.1, page 12-29 for instructions.	
2. Detach the line source compartment from the AC option bracket.	
See section 12.5.1.2, page 12-33 for instructions.	
3. Remove the covers from the line source compartment.	
See section 12.5.3.1, page 12-38 for instructions.	

Procedure	***Details***
The photo on the right shows the line source housing inside the compartment. 4. Locate the transportation screws sitting in the spare holes in the line source housing.	
5. Move the two transportation screws to the center holes as shown in the photo on the right. 6. Tighten the transportation screws so that they lock the shutter in the closed position.	

WARNING

Make sure that the transportation screws are in place and locking the shutter before attempting to remove the source holder. Failing to lock the shutter may cause you to be exposed to radiation from the source inside the holder.

Procedure	***Details***
7. If required, turn the motor shaft by hand (turn the wheel located next to the motor) to translate the line souce housing to a more convenient position inside the compartment. 8. Use a 2.5 mm Allen key to loosen and remove the 8 screws holding the line source housing to the two slide bearings.	
9. Push the slide bearings out from under the line source housing. 10. Carefully turn the line source housing in the direction indicated on the photo and lift it out of the compartment. **Note**. To prevent damage to housing shutter components, it is important to turn the line source housing in the indicated direction when removing the source housing.	

Installing a New Line Source

Line sources are delivered from the vendor installed inside a line source housing and ready to be mounted inside the CardioMD AC option line source compartment.

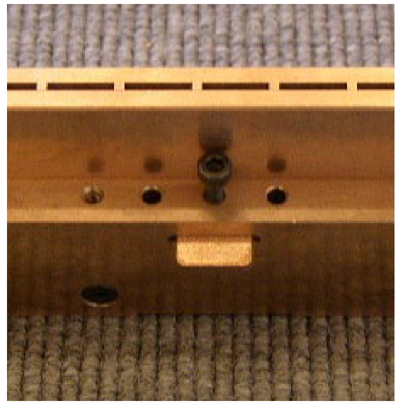
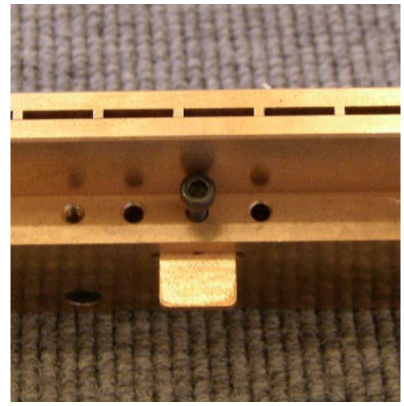
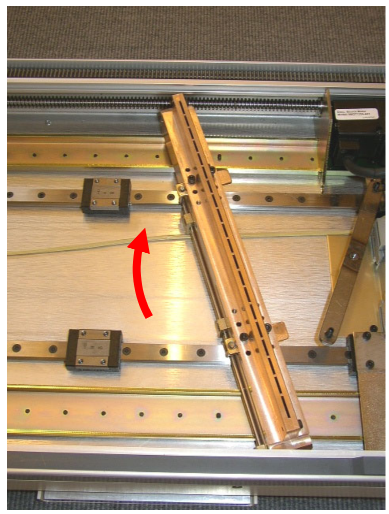
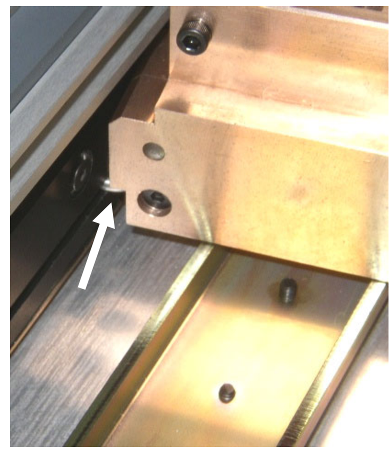
Before line sources are shipped by the vendor, an initial leak test is performed. Furthermore, leak tests must be performed and documented by the local Radiation Safety Officer (RSO) upon receipt of the line source or as required by radioactive materials Licensing Agency.

To perform a line source leak test, proceed as follows:

Procedure	***Details***
1. Obtain a cotton-tipped swab and wipe the swab along the aperture of the line source housing number one. Make sure that the shutter is closed to avoid any unnecessary radiation exposure. The aperture of the line source housing is the area from which radiation is emitted. 2. Place the cotton-tipped swab in a well counter or equivalent device capable of detecting 0.001 µCi. 3. Repeat the same procedure for line source housing number two.	

For further information, refer to the CardioMD Operator's Manual Chapter 7 *CardioMD AC Option*.

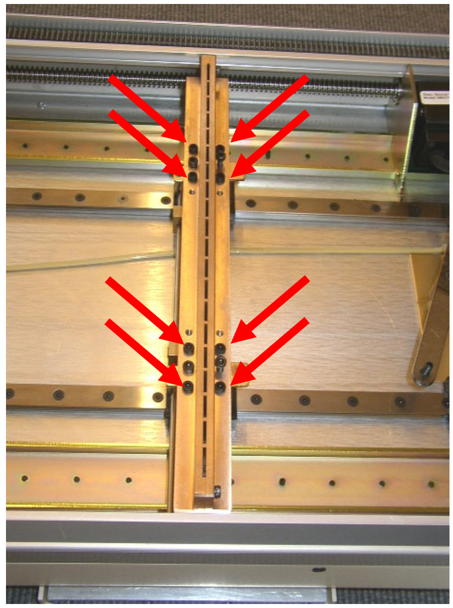
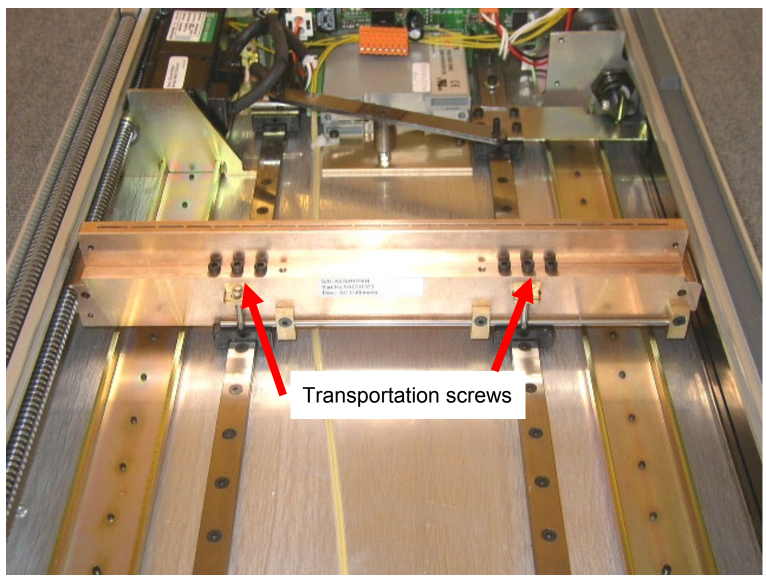
Procedure	***Details***
The photo on the right shows the line source housing. When the line source housing is supplied from the vendor, the line source attenuator should be in the closed position.	

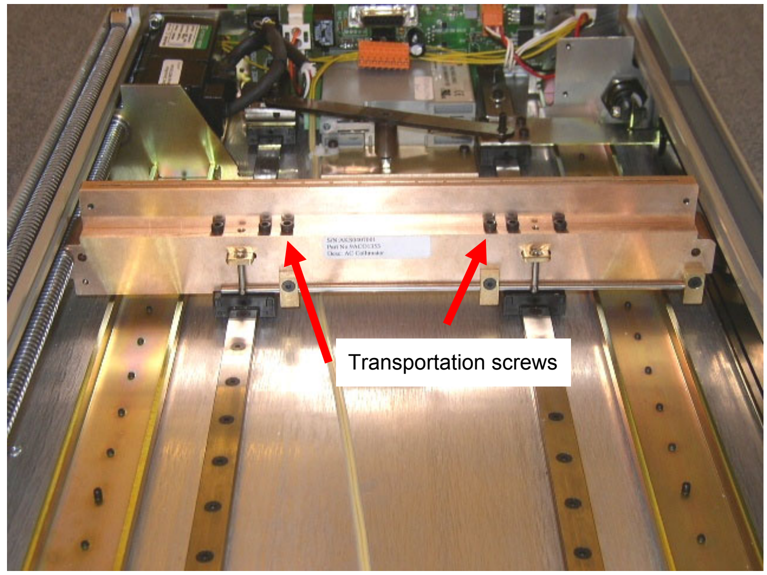
Procedure	*Details*
1. Check that the line source attenuator is in the closed position. If required, see instructions in section 12.5.3.9, page 12-75 on changing the position of the attenuator.	 Attenuator in closed position  Attenuator in open position
The line source housing must be mounted inside the line source compartment on top of two slide bearings running on the rails in the bottom of the compartment. 2. Place the line source housing inside the compartment as shown. 3. Carefully turn the line source housing in the direction indicated on the photo so that it ends up being perpendicular to the rails in the line source compartments.	 

CAUTION

Caution. It is important to turn the line source housing in the indicated direction when installing it. The reason for this is that the shutter lever on the line source housing must fit into the groove in the locking plate.

The functioning of the shutter mechanism is explained on page 12-19.

Procedure	***Details***
4. Carefully push the slide bearings into position underneath the line source housing. 5. Use a 2.5 mm Allen key to mount the 8 M3 × 30 Allen screws, securing the line source housing to the slide bearings. **Note**. Before fastening the screws, check that the line source housing is perpendicular to the rails, e.g. by aligning one of its sides with screw heads in the two rails. If required, turn the motor shaft by hand to translate the line souce housing to a more convenient position inside the compartment.	
The photo on the right shows the line source housing installed on the slide bearings and with all screws mounted. 6. Finally, remove the two transportation screws securing the line source housing shutter mechanism.	

Procedure	*Details*
7. To ensure that the transportation screws can always be found when required, place them in the spare holes provided in the line source housing. 8. Tighten the transportation screws to ensure that they will not come loose and fall out during operation of the CardioMD AC option.	
9. After exchanging the line source, grease the acme screw inside the line source compartment. See section 12.8.1, page 12-116 for instructions.	

Returning the Used Line Source to the Vendor

WARNING

Gd-153 source management is the sole responsibility of the site Radioactive Materials License holder. Philips Medical Systems employees are not authorized to participate in the legal, safe return of radioactive sources and should not be involved in the packaging, documentation, and/or shipment of radioactive sources.

The site Radioactive Materials License holder must return used Gd-153 lines sources to:

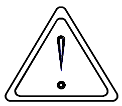
Isotope Products Laboratories
Medical Imaging Division
24937 Tibbitts Avenue
Valencia, Ca 91355

When shipping line sources, the site Radioactive Materials License holder should either use the original packaging material or the packaging material that came with the replacement line sources.

12.5.3.9 Opening the Line Source Attenuator

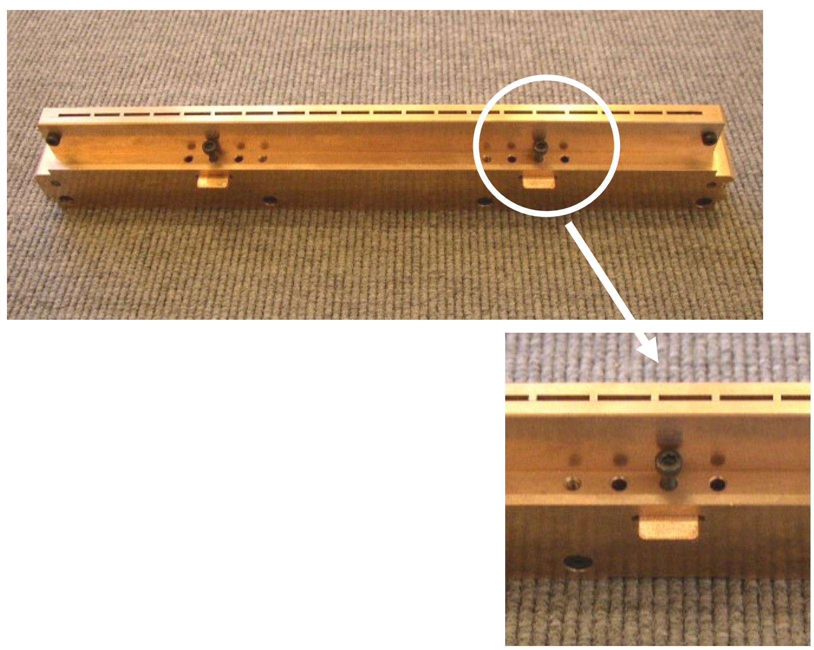
After approximately one year of using a line source, the line source housing's attenuator will have to be opened in order to ensure that the line source is used optimally.

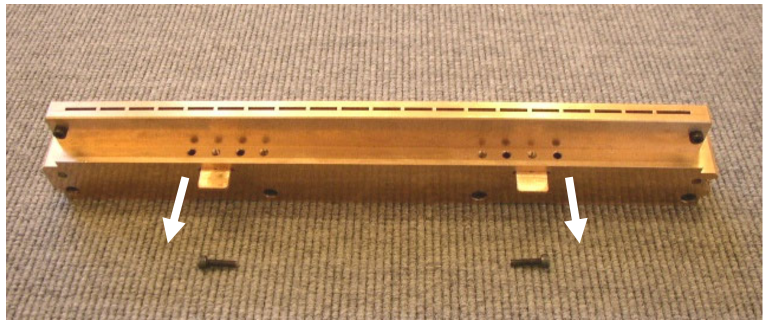
Procedure	***Details***
1. Remove the line source housing from the line source compartment, as described in the section *Removing the Line Source Housing*, page 12-68.	



WARNING

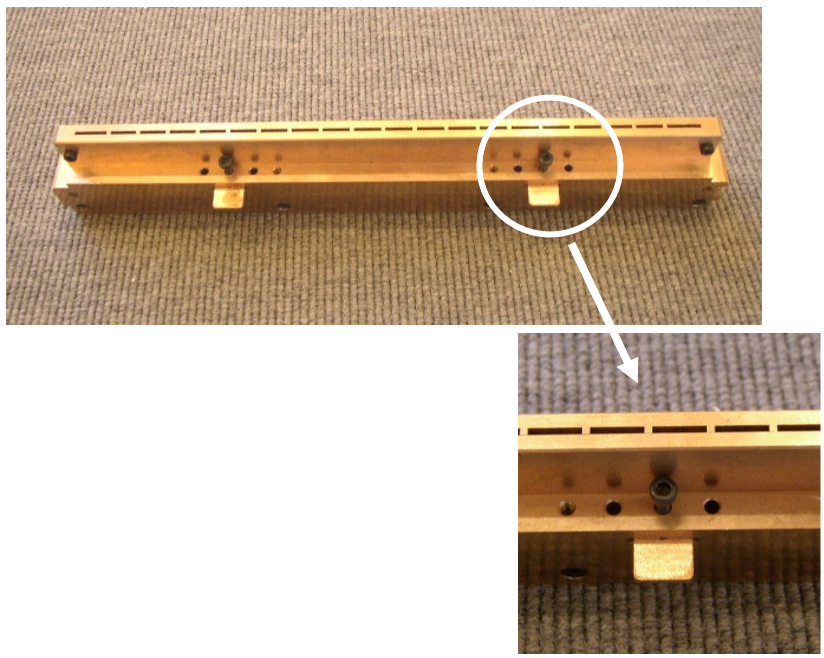
Make sure that the transportation screws are in place and locking the shutter before attempting to remove the source holder. Failing to lock the shutter may cause you to be exposed to radiation from the source inside the holder.

Procedure	***Details***
The photos on the right show the attenuator in the closed position. The attenuator is in this position when the line source housing is delivered.	

Procedure	***Details***
2. Use a 2.5 mm Allen key to remove the two screws holding the attenuator. 3. Pull out the attenuator in the direction of the arrows.	

CAUTION

Caution. The attenuator consists of four separate copper strips. Be careful to retract all four strips, aligning the holes of each strip exactly with the holes in the line source housing.

Procedure	***Details***
4. Remount the two screws to lock the attenuator in the open position. The photos on the right show the attenuator in the open position.	

5. Reinstall the line source housing inside the line source compartment. See instructions in the section *Installing a New Line Source*, page 12-71.
6. After reinstalling the line source housing, grease the acme screw inside the line source compartment. See section 12.8.1, page 12-116 for instructions.
7. Go through the procedure described in section 12.6.5, page 12-109 to ensure that the CardioMD system is ready for use.

12.5.3.10 Mounting Line Source Compartment Covers

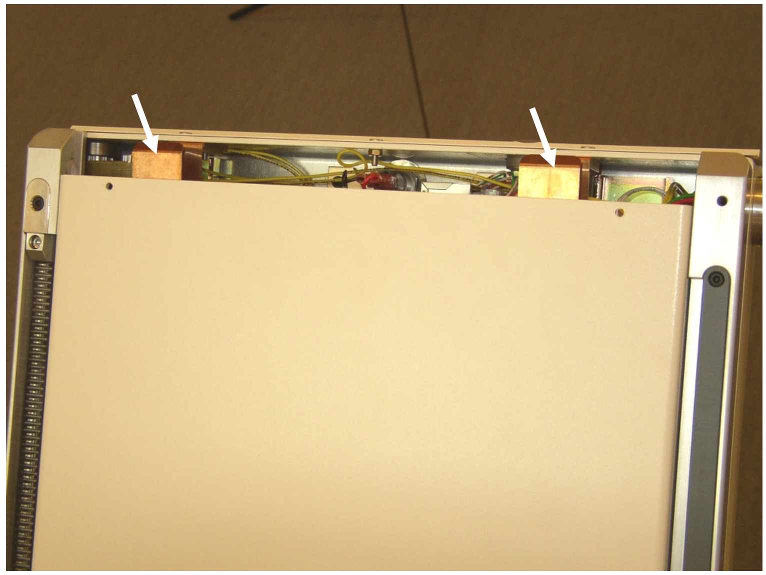
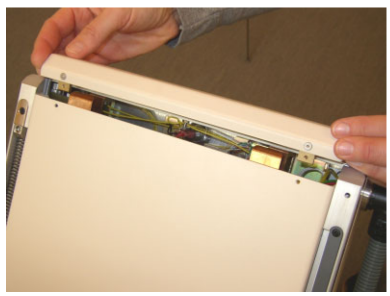
This section explains how to install line source compartment covers:

- While the transmission scanner is mounted on the detector, and
- When the transmission scanner is dismounted and the line source compartment has been detached from the AC option bracket.

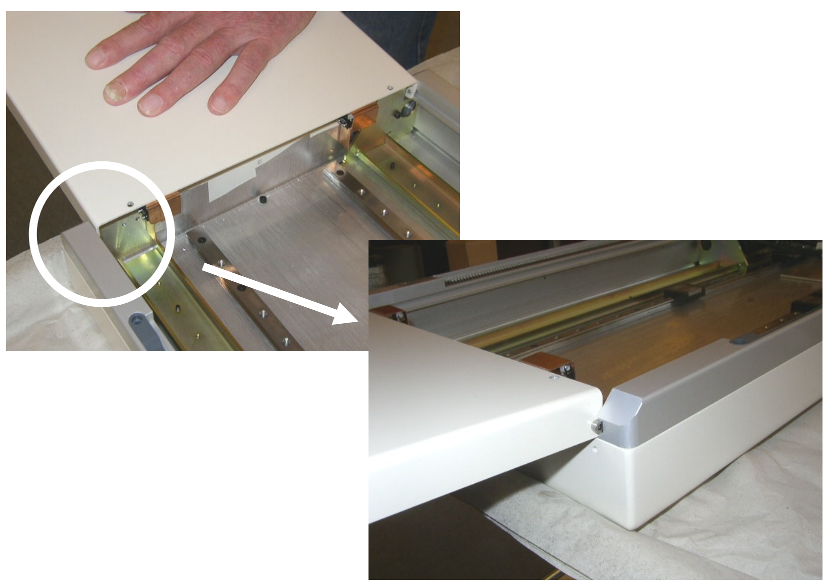
Transmission Scanner Mounted on Detector

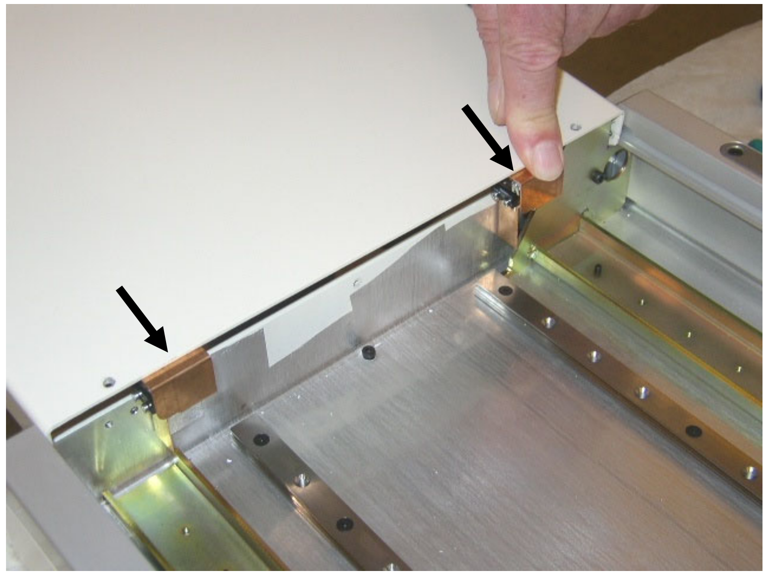
Procedure	***Details***
1. If required, use the hand controller to position the detector assembly conveniently for access to the transmission scanner you are going to work with.	
2. If required, use the crank supplied with the CardioMD system to position the line source compartment conveniently.	
3. Insert the service cover at the end of the line source compartment. The small bolts mounted at the corners of the cover must fit into the groove in the line source compartment.	

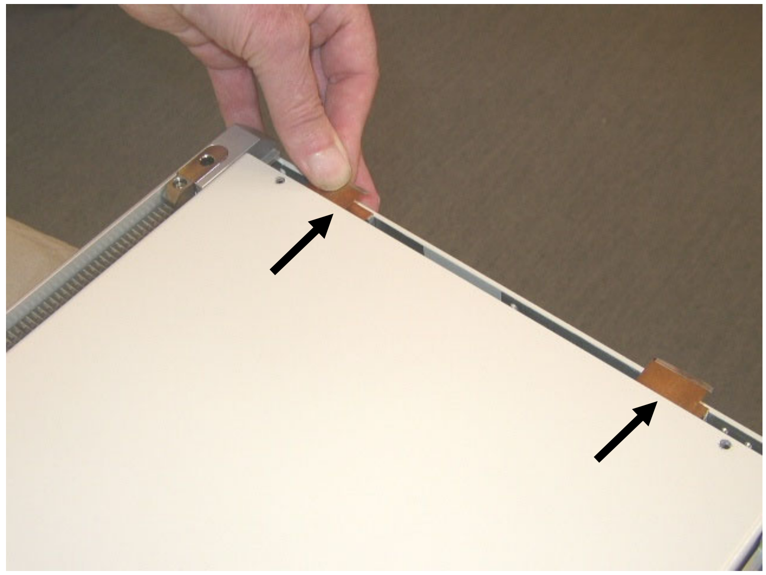
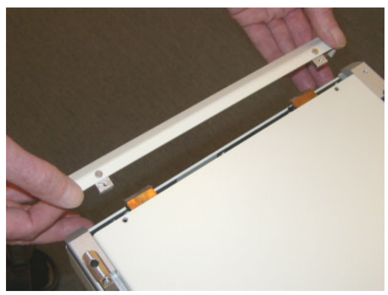
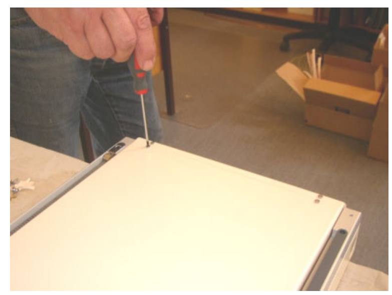
Procedure	*Details*
4. Ease the cover past the collision sensors, pressing down on each sensor, one after the other.	
5. Slide the cover into place, taking care to fit the two small bolts at the other end of the cover into the groove of the line source compartment.	

Procedure	*Details*
6. Again, press down each collision sensor at the other end of the line source compartment, one by one, easing the cover into place.	
7. Remount the edge cover and fasten it using the two Torx screws previously removed from the service cover.	 

Transmission Scanner Dismounted

Procedure	*Details*
1. Insert the service cover at the end of the line source compartment. The small bolts mounted at the corners of the cover must fit into the groove in the line source compartment.	

Procedure	***Details***
2. Ease the cover past the collision sensors, pressing down on each sensor, one after the other.	
3. Slide the cover into place, taking care to fit the two small bolts at the other end of the cover into the groove of the line source compartment.	

Procedure	*Details*
4. Again, press down each collision sensor at the other end of the line source compartment, one by one, easing the cover into place.	
5. Remount the edge cover and fasten it using the two screws previously removed from the service cover.	 
6. Repeat the procedures outlined above for the other transmission scanner.	

12.5.3.11 Mounting Transmission Scanners

Instructions for mounting the transmission scanners on the detectors are provided in section 12.6.3.4 on page 12-103.

12.5.3.12 Aligning Transmission Scanners

The AC option transmission scanners must be aligned:

- When the AC option is installed for the first time
- Whenever a line source compartment has been detached from the AC option bracket
- Whenever a line source housing has been removed from the line source compartment
- After installation of new line sources
- When the CardioMD system issues an error message saying "Line source offset has exceeded +/– X mm".

Note. Aligning transmission scanners is performed with the transmission scanners mounted on the detectors.

Before Beginning

Before starting the alignment, ensure that the CardioMD is powered up and that the CardioMD software is running on the acquisition PC.

Checking Which Transmission Scanner needs Aligning

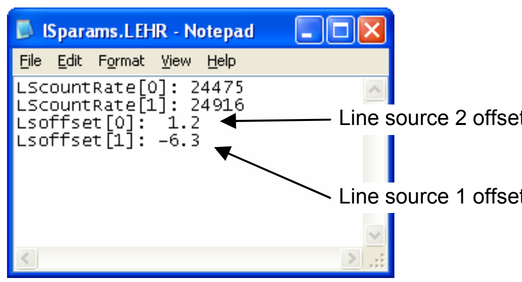
If the reason for aligning a transmission scanner is the line source offset error message, you need to establish which of the transmission scanners needs aligning. Proceed as follows:

Procedure	***Details***

1. On the acquisition PC, locate the folder `C:\cardiocam\Calibrations\Line Source`.

This folder contains one or two files with names of the form lsparams.<collimator type>, that is, `lsparams.LEHR` or `lsparams.LEGP`.

2. Open the file corresponding to the collimator currently mounted on the CardioMD system.



The contents of the file look similar to the example shown to the right.

Note. The entry Lsoffset[0] gives the line source offset value for the line source exposing detector 1, that is, transmission scanner 2. Lsoffset[1] gives the line source offset for the line source exposing detector 2, that is, transmission scanner 1.

In the example, the entry `Lsoffset[1]` indicates that the offset problem concerns transmission scanner 1 (offset value exceeds +/– 5 mm).

3. Click the Close button to exit the Notepad program.

Aligning Transmission Scanner

Procedure	***Details***

1. Remove the line source compartment covers from the transmission scanner to be aligned.

Instructions are provided in section 12.5.3.1, page 12-38.

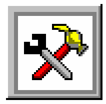
Next, you need to position the line source at the center of the line source compartment.

One way of accomplishing this is to initiate a

Procedure	***Details***

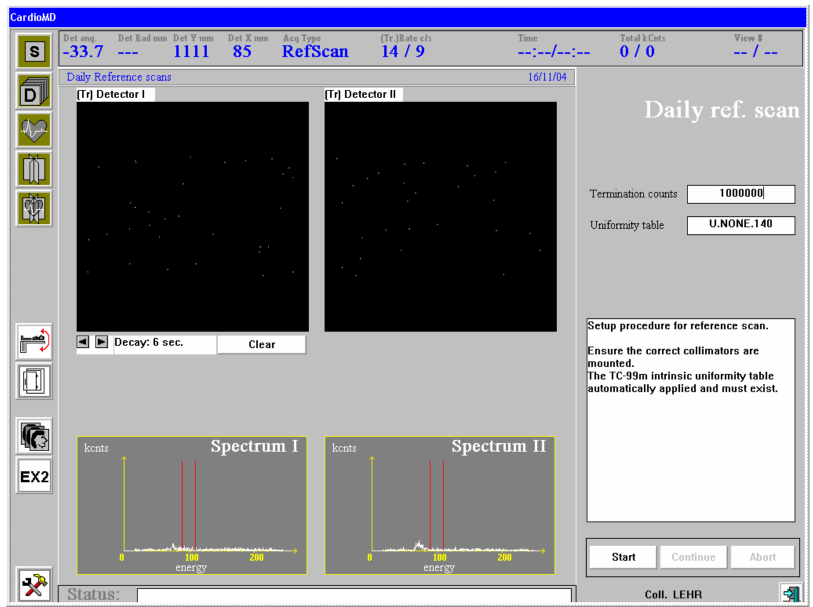
reference scan, wait until the the line source is at center position and then stop the reference scan. Proceed as follows:

2. On the Persistence page, click the Tools button to display the Calibration & configuration menu.



3. Click the Daily reference scan button.

The Daily Reference Scan page appears.



4. Set Termination counts to 1000000 (1 million).
5. Click Start to start the reference scan.
6. Wait until the line source of the transmission scanner that is to be aligned is translated to center position inside the line source compartment.

Note. This procedure is most convenient for transmission scanner 2. When aligning transmission scanner 1, you need to wait for transmission scanner 2 to complete its entire reference scan before transmission scanner 1 moves to center position.

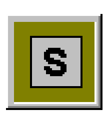
7. Click Stop to stop the reference scan.
8. Click Exit and then OK to interrupt the reference scan and close the Daily Reference Scan page.

9. In the Calibration & Configuration menu, click Exit to return to the Persistence page.

Alternatively, the line source housing can be moved to center position by means of software commands sent to the line source motion controller via an RS 232 connection to the EDC board. See the section *Manual Control of Line Source Motions*, page 12-24 for details.

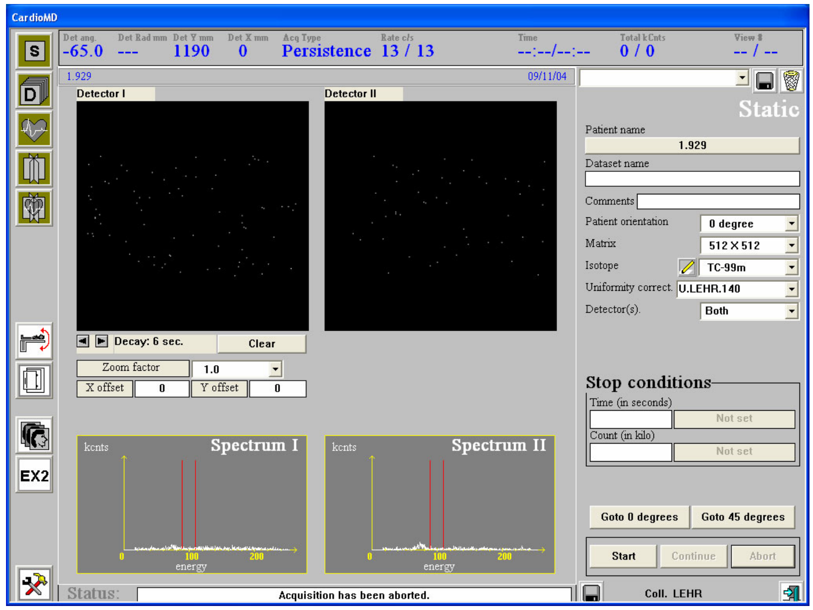
Next, set up a static acquisition:

10. On the Persistence page, click the Static button.



Procedure	Details

The Static page appears.

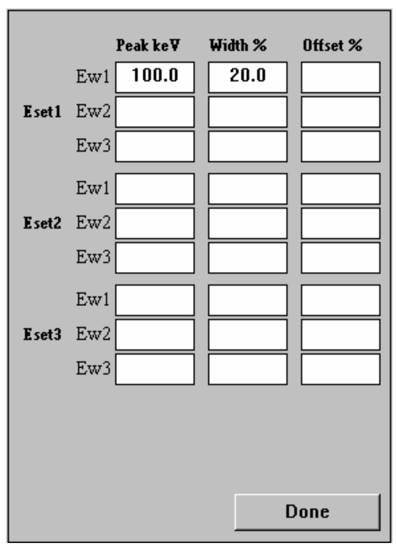


11. Click on the Pencil button to access energy setup.

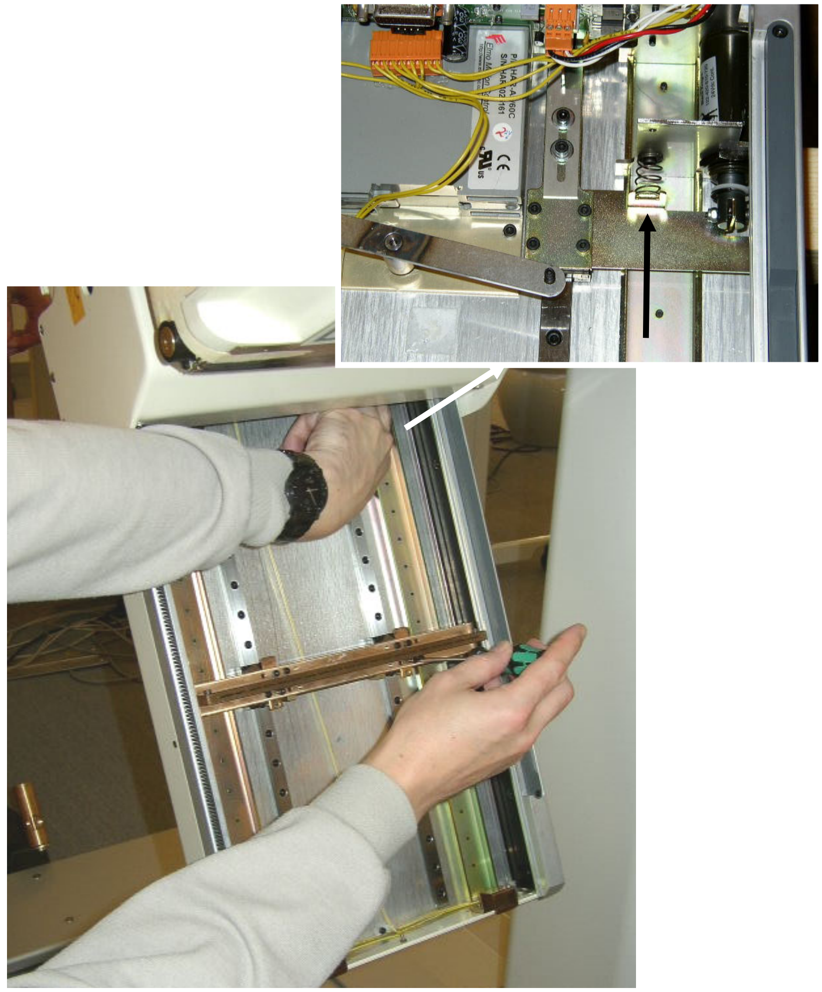
12. For Eset1, enter data for energy window 1 (Ew1):
    Peak keV: 100.0
    Width %: 20.0
13. Leave Eset2 and Eset3 blank.
14. Click Done.

The Isotope setting is not important.

15. Click Start.



Now you need to open the line source shutter of the transmission scanner that you are aligning. Proceed as follows:

Procedure	*Details*
16. With one hand, press the actuator bracket upwards to open the shutter. 17. Use the transportation screws to lock the line source shutter in the Open position. When the line source shutter is locked open, the acquisition PC issues a pop-up warning and emits a continuous audible warning signal. This is normal.	

WARNING

When the line source shutter is open, a collimated beam of radiation is emitted from the line source. Make sure to *never* leave the system unattended while the transportation screws are locking the line source shutter in the open position.

Procedure	*Details*
18. Use a Torx T10 key to loosen the four torx screws in each side of the AC option bracket holding the line source compartment.	
19. While monitoring the count rate on the acquisition PC monitor, gently rock the line source compartment back and forth until it is in the position yielding the maximum count rate.	

Note. If the count rate is fluctuating a lot, it may help to expose the opposite detector to a Co-57 or Tc-99m point source.

Procedure	***Details***
20. Tighten the torx screws in both sides of the AC option bracket.	
21. Remove the transportation screws from the line source housing and check that the line source shutter closes.	
22. Acquire a new reference scan.	
See the CardioMD Operator's Manual, Chapter 12 *CardioMD AC Option* for instructions.	
23. Install the line source compartment covers.	
Instructions are provided in section 12.5.3.10, page 12-77.	

Note. Acquiring a new reference scan after aligning one or both transmission scanners is mandatory.

12.6 Installation

This section provides instructions for installing the CardioMD AC Option. For information on installing the CardioMD system, refer to Chapter 8 *Installation Procedure* of the CardioMD Service Manual. Instructions for operating the CardioMD system, including the AC Option, are provided in the accompanying CardioMD Operator's Manual.

12.6.1 Preparing for the Installation

This section provides instructions for unpacking the CardioMD AC Option.

The main parts of CardioMD AC Option are:

- 9ACO1347 Transmission scanner for detector 1
- 9ACO1371 Transmission scanner for detector 2
- A kit for upgrading a CardioMD system to support attenuation correction. This kit includes:
  - Electrical parts and cables for the CardioMD gantry
  - Electrical parts and cables for the CardioMD detector
- Bushings with bolts and washers forming the mechanical attachment for the transmission scanners on the CardioMD detectors
- 9CSY1381 FOV mask
- 9CSY0906 CardioMD software installation CD
- 1MAN0153 CardioMD Operator's Manual and 1MAN0158 CardioMD Service Manual.

Note. Line sources are *not* included with the CardioMD AC option but are delivered, mounted in line source housings, directly from the line source vendor.

Note. The CardioMD AC Option requires EDC module firmware revision 7CTL0095-E05 or later. The firmware version can be determined from the system log file. Check the most recent file in the directory `C:\cardiocam\SystemLog`.

12.6.1.1 Shipping Container and Weight

The CardioMD AC option is shipped in a single container. Table 12.6 lists size and weight, including pallet.

Shipping box with	*Shipping weight*	*Size $W \times D \times H$*
CardioMD AC Option complete	122 lbs. 55 kg	31.5 × 15.7 × 25.6 inch 80 × 40 × 65 cm

Table 12.6 Shipping container, weight and dimensions

12.6.1.2 Tools

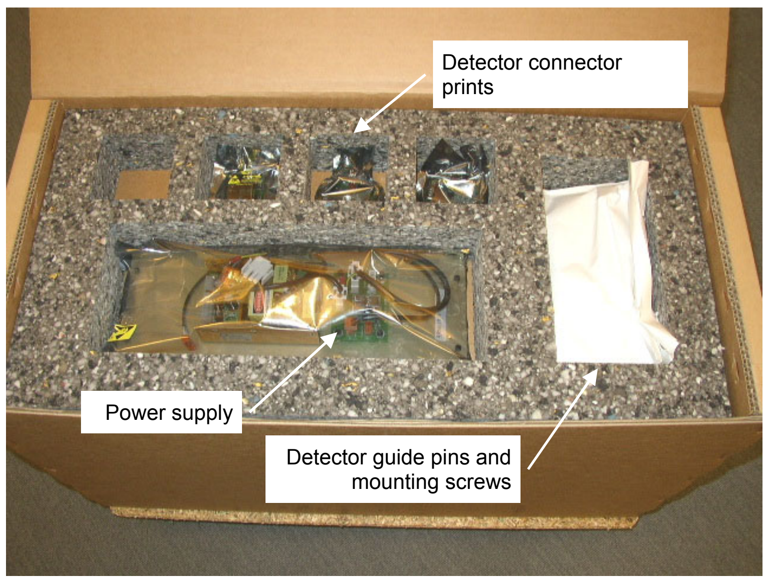
Tools Shipped with the AC Option

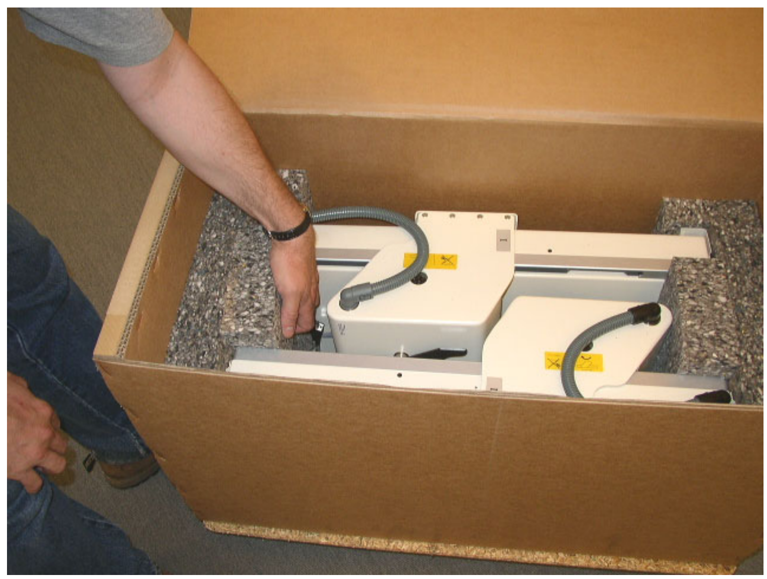
None.

Tools not Shipped with the AC Option

- 3 and 5 mm standard screwdrivers
- Wrench: 5 and 7 mm
- Metric Allen keys: 2, 2.5, 3 and 5 mm
- Torx key No. 9
- A pair of pliers.

12.6.1.3 Unpacking

Procedure	*Details*
1. Cut and remove the nylon straps holding the container to the pallet and open the box. 2. Remove the envelope at the top containing the FOV mask and the Service Manual.	
You now have access to the components shown in the photo on the right. 3. Remove the components, the styrofoam holding them and the cardboard below.	

Procedure	***Details***
4. Remove the envelope containing cables and the plastic bag with the Operator's Manual.	
5. Remove the styrofoam to the side of this transmission scanners.	

Procedure	***Details***
6. Take out one transmission scanner, and then the other, from inside the box. You are now ready to start the installation of the CardioMD AC option as described in the following sections.	

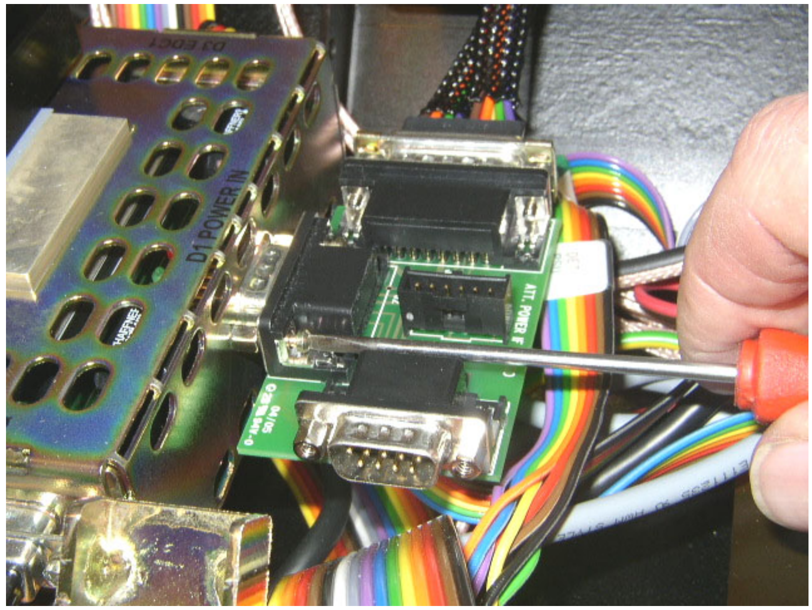
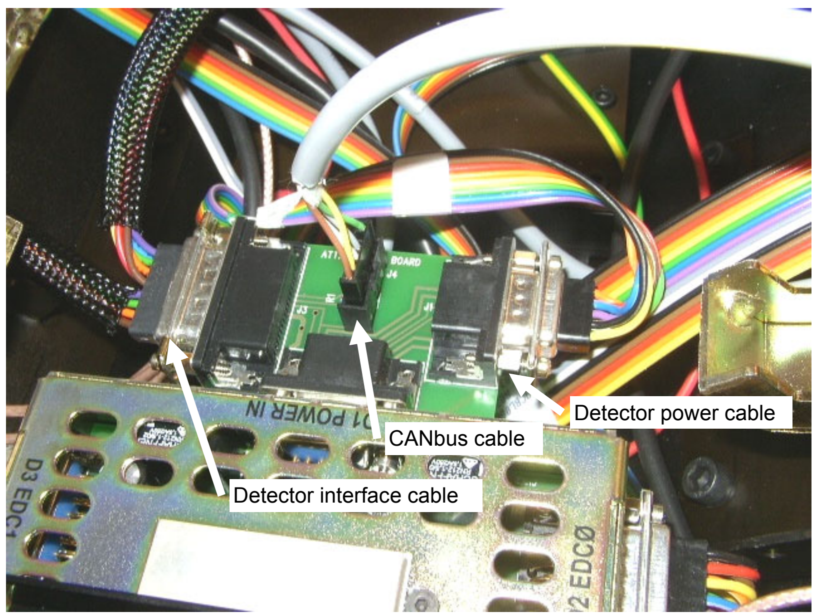
WARNING

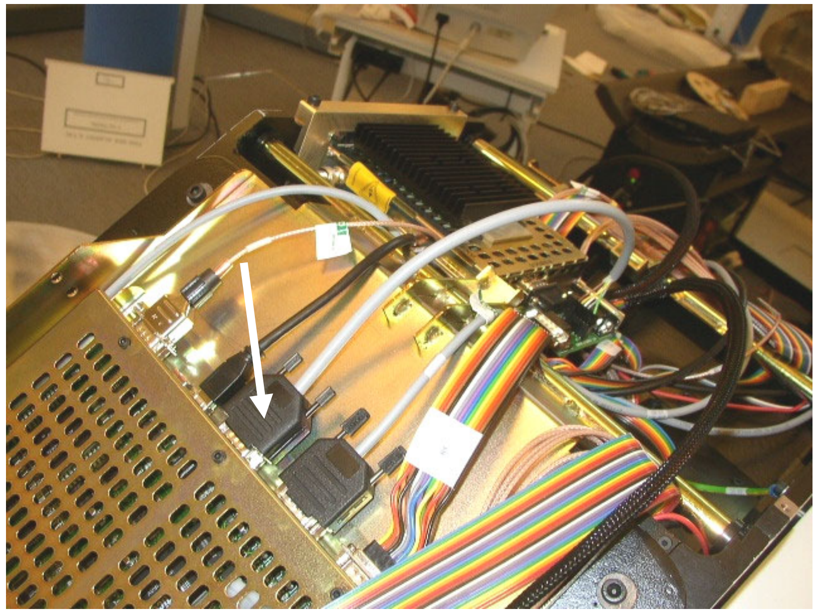
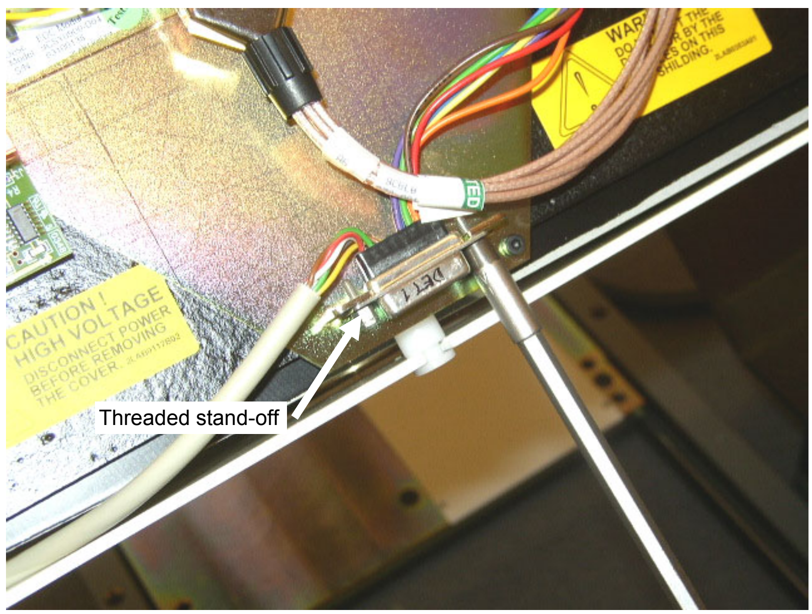
Be careful when handling the transmission scanners – they are quite heavy. Do *not* drop a transmission scanner. Dropping a transmission scanner may cause personal injury or damage the equipment.

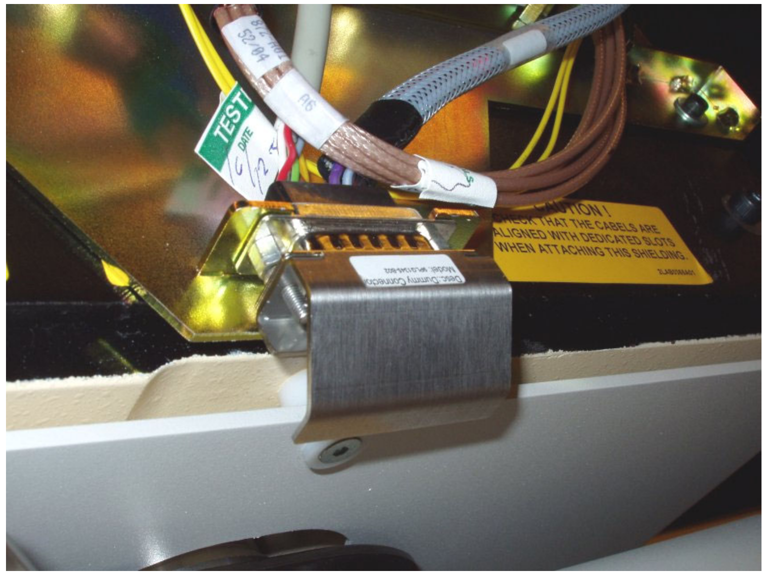
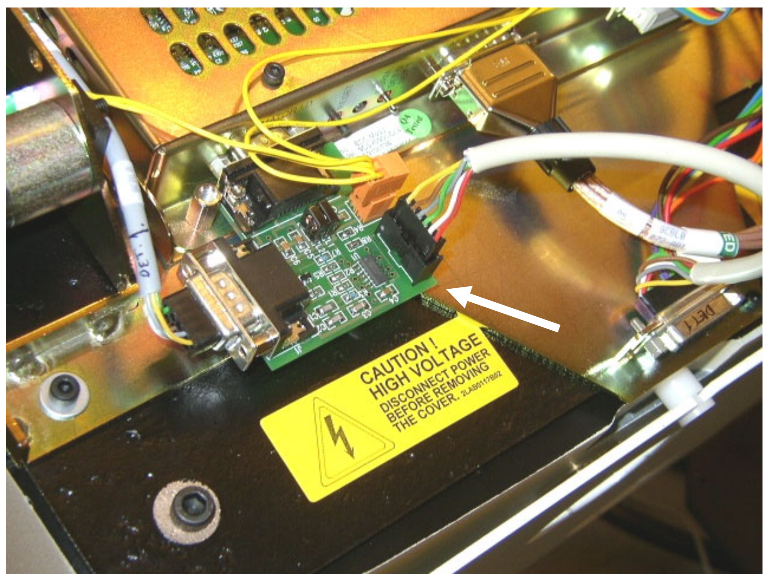
12.6.2 Electrical Installation

12.6.2.1 Modifying Detector Cabling

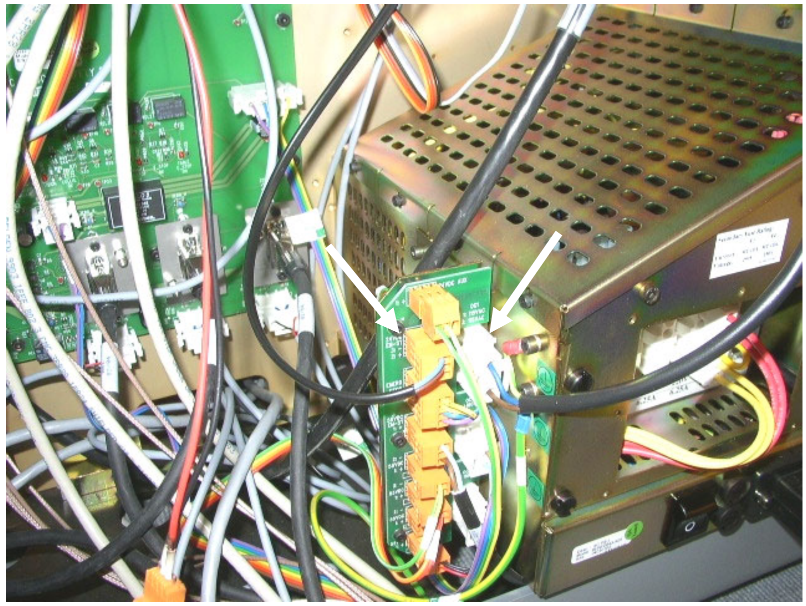
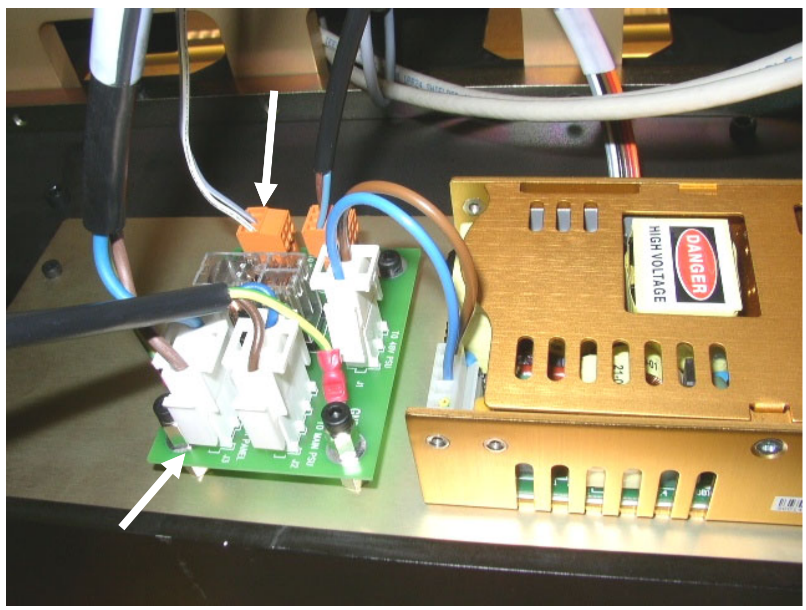
Procedure	***Details***
1. Follow the procedure provided in Chapter 3 *Getting Started* of the CardioMD Operator's Manual to shut down the system.	
2. When the system is powered down, disconnect the mains cable from the mains inlet on the rear of the table console.	
3. Remove the detector top cover.	
4. Disconnect the input power connector from the detector power supply.	

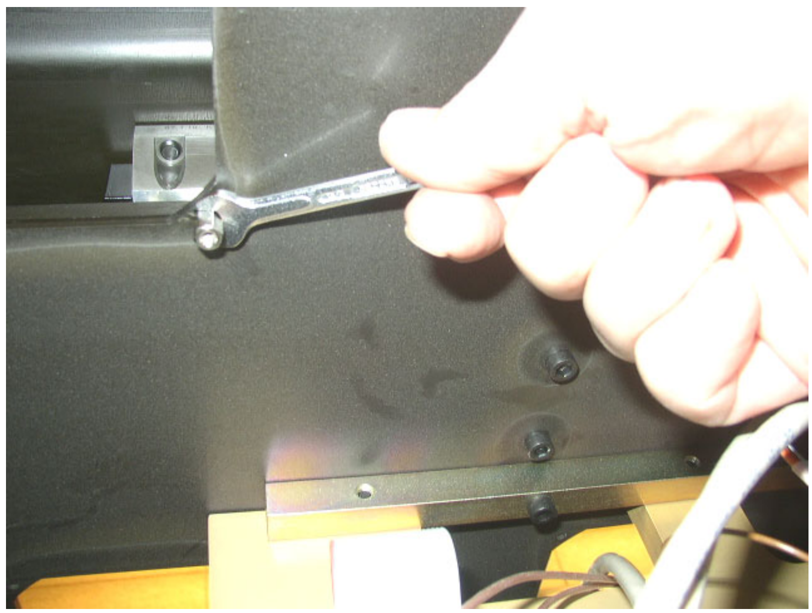
Procedure	*Details*
5. Attach the AC Option's power interface board (9ACP1316) to the detector power supply.	
6. Plug the detector power cable into the mating connector on the power interface board. 7. Attach the AC Option's detector interface cable (9CBL1313) to the DB15 connector on the power interface board. 8. Attach the AC Option's CANbus interface cable (9CBL1314) to the 6-way connector on the power interface board.	

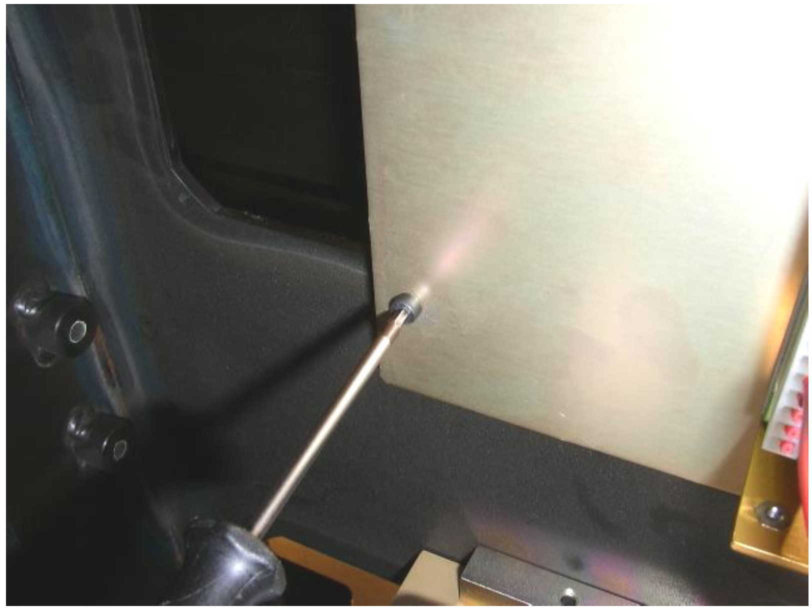
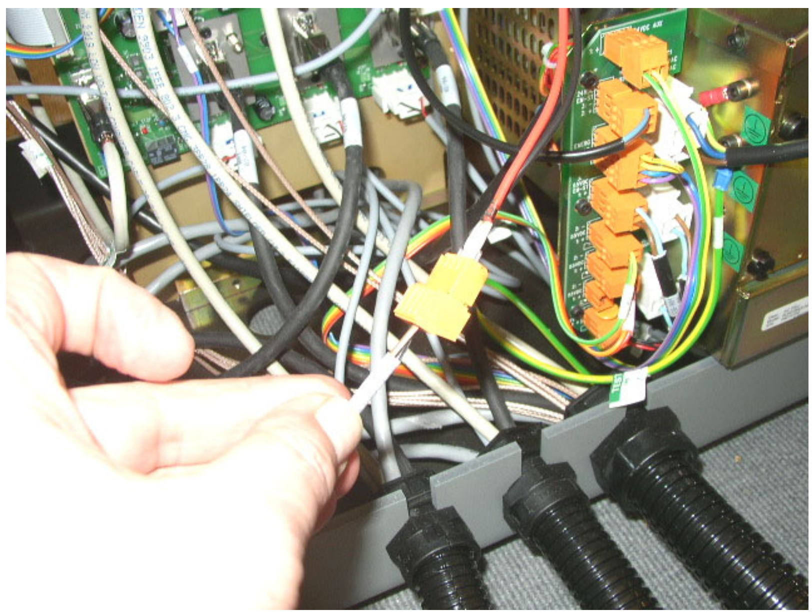
Procedure	***Details***
9. Remove the CANbus terminator from connector A3 on the EDC board on detector 1. 10. Connect the AC Option's CANbus interface cable (9CBL1314) to connector A3 on the EDC board of detector 1.	
11. On each detector, mount one of the female DB15 connectors that are part of the AC Option's detector interface cable (9CBL1313) on the brackets provided. Use the threaded stand-offs provided. **Note**. The two female DB15 connectors that are part of the AC Option's detector interface cable carry identical signals. Hence, they are not detector-specific.	

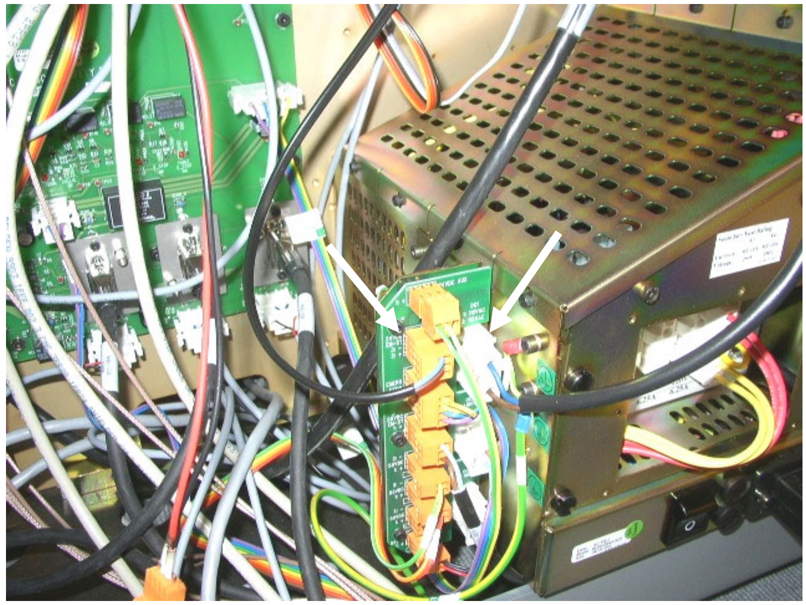
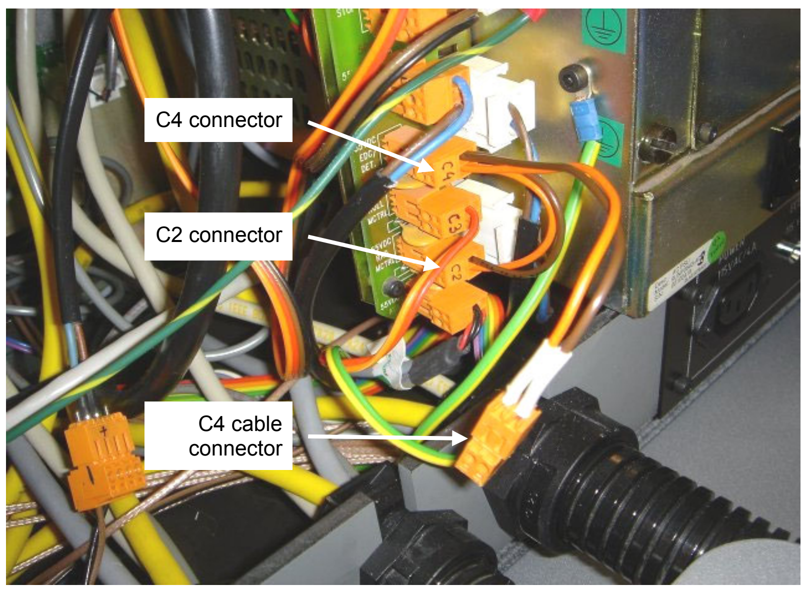
Procedure	***Details***
12. When the DB15 connector is in place, insert the collision circuit jumper (9PLG1345) supplied with the AC option. **Note**. Installation of the collision circuit jumper is required in order to allow the CardioMD system to move before the transmission scanners are installed.	
13. On both EDC boards, remove the cover collision board (9COL0899) and replace it with the EDC AC IF board (9ACI1312). 14. Reestablish the cable connections existing previously to the new board. 15. Plug the 6-way plug from the AC Option's detector interface cable (9CBL1313) into the mating header.	

12.6.2.2 Installing the AC Option Power Supply

Procedure	***Details***
1. Remove the back cover from the table console. 2. On the system's main power supply (PSU), disconnect the orange 3-way plug from PSU connector C6 (24V EM-ST). 3. On the main PSU, disconnect the white 3-way plug from PSU connector OC1 (115VAC) and unscrew the associated ground wire.	
4. Place the AC Option power supply (9POW1315) on the floor next to the main PSU. 5. Now plug the two connectors that you just removed from the main PSU into the mating headers on the AC Option power supply. 6. Attach the ground wire to the available post. **Note**. There are two of each type of header. Headers of identical type can be swapped as they are connected in parallel.	

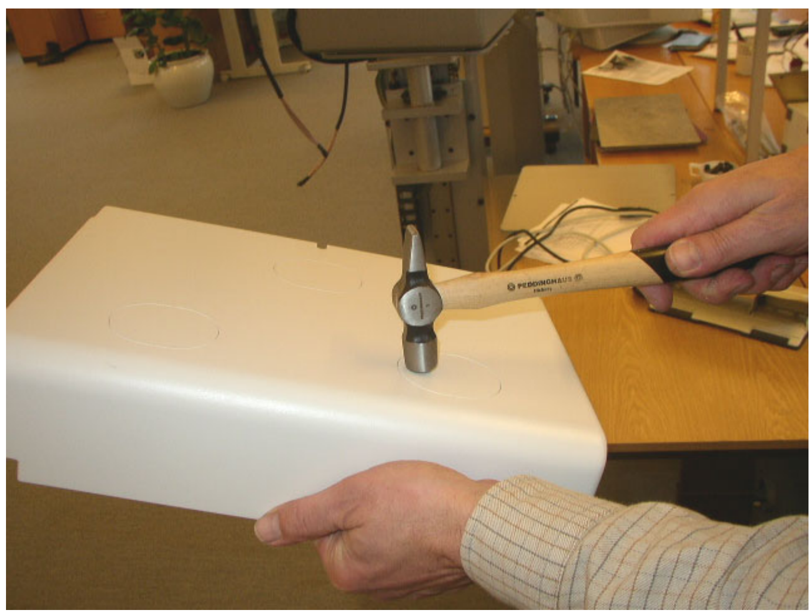
Procedure	***Details***
7. Using a 2 mm Allen key, mount the 4 set screws provided (2SCR0867) in the table console frame in the four positions indicated in the photo on the right. The top of set screws should be flush with the surface.	
8. From inside the table console frame, use a 7 mm wrench to fit the stand-offs provided (2STY0903) on each of the four set screws now protruding.	

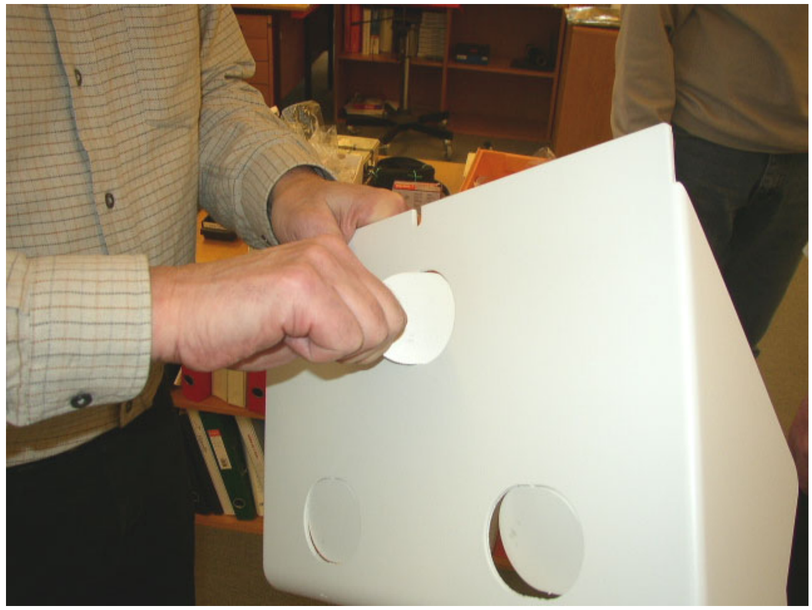
Procedure	***Details***
9. Using the 4 pcs. M4 socket-head cap screws provided (2SCR0223), mount the AC Option power supply (9POW1315) inside the table console frame on the four stand-offs just mounted.	
10. Locate the orange-colored, wire-mounted 4-way connector plug inside the table console. 11. Plug it into the orange-colored, wire-mounted 4-way connector socket attached to the AC Option power supply.	

Procedure	*Details*
12. Plug the orange-colored 3-way plug from the AC Option power supply into connector C6 (24V EM-ST) on the main PSU. 13. Plug the white 3-way plug from the AC Option power supply into connector OC1 on the Main PSU (115VAC) and attach the associated ground wire with the M4 screw.	
14. Unplug the cable connector C4 from the main PSU connector panel. 15. Connect the 55 V split cable 9CBL1482 to the main PSU connector panel by inserting the plugs C2 and C4 into the connectors labeled C2 and C4, respectively. 16. Connect the opposite end of the 55 V split cable (labeled C4) to the cable connector C4 that was removed from the main PSU connector panel in step 14.	

12.6.3 Mechanical Installation

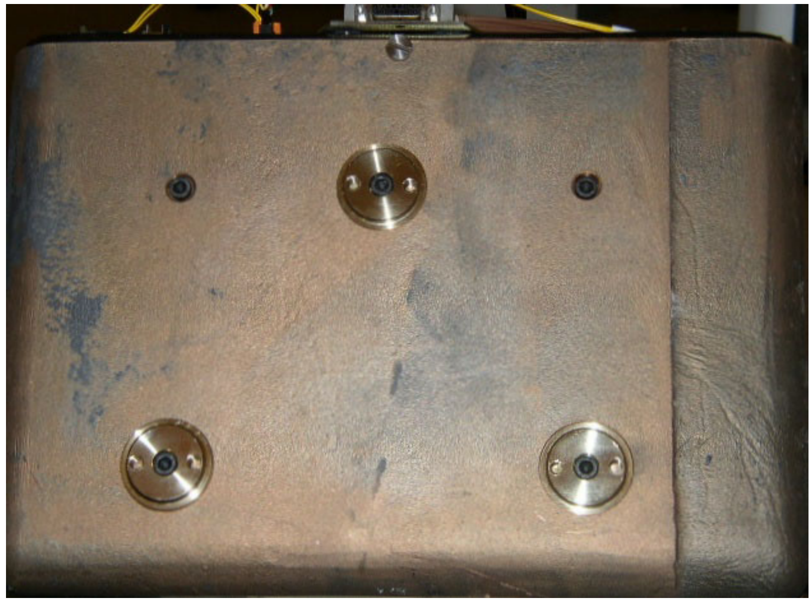
12.6.3.1 Preparing Detector Covers

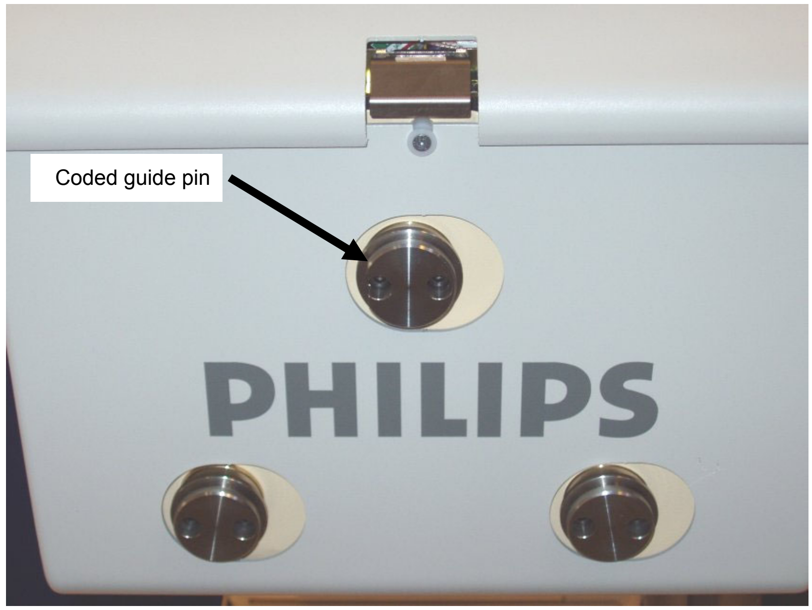
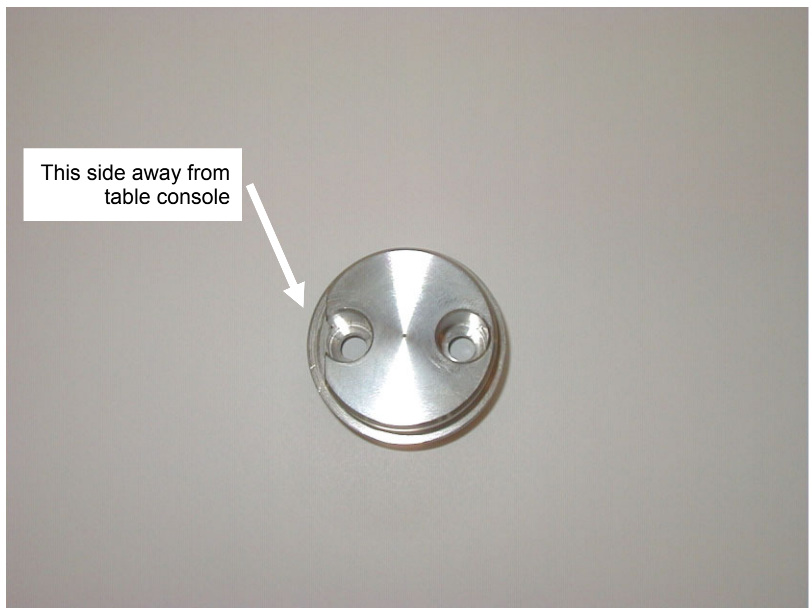
Procedure	*Details*
1. Remove the pre-cut knock-out pieces from both ends of the detector top cover, using an appropriate pair of pliers. **Caution**. Be careful when removing the knock-out pieces. Using excessive force may damage other parts of the cover.	
2. Dismount the two detector end covers. 3. If necessary, use a small hammer to remove the three pre-cut knock-out pieces in both covers. 4. Take care not to damage the detector cover outside of the knock-out pieces.	

Procedure	***Details***
5. Once partly detached, the knock-out pieces can be removed by hand.	
6. Re-mount detector the end covers.	

12.6.3.2 Mounting Guide Pins on Detectors

Three guide pins must be mounted on the end piece of each detector. These guide pins fit into sockets in the bracket of the transmission scanner and carry the transmission scanner when it is mounted on the detector.

Procedure	***Details***
The photo on the right shows the detector end piece without the cover.	
The CardioMD AC Option comprises 2 sets of 3 guide pins, complete with Allen screws and lock washers, to be mounted on the end piece of each detector. The photo on the right shows the guide pins for one detector.	

Procedure	*Details*
1. Place a lock washer over each Allen screw, concave side of washer facing the screw head. **Caution**. Make sure to place one lock washer over each Allen screw. Leaving out the washer entails a risk of damaging the detector. 2. Mount the 3 guide pins on the end piece of each detector, taking care to mount the coded guide pin towards the top of the detector (where the EDC board is located). The photo on the right shows detector 1 with covers mounted.	
Note. One of the guide pins for each detector is coded and must be mounted at the top of the detector, with its flat side facing *away* from the table console. By doing this, you ensure that the correct transmission scanner is placed on each detector: • Transmission scanner 1 must be mounted on detector 1 (facing detector 2), and • Transmission scanner 2 must be mounted on detector 2 (facing detector 1).	

12.6.3.3 Installing Line Sources

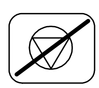
Line sources installed inside line source housings are shipped separately from the source vendor. A line source must be installed in each line source compartment.

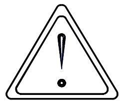
For each transmission scanner, installing the line source involves the following steps:

1. Detaching the line source compartment from the AC option bracket.
   See section 12.5.1.2, page 12-33 for instructions.
2. Removing the covers from the line source compartment.
   See section 12.5.3.1, page 12-38.
3. Installing the line source housing inside the compartment.
   See the section *Installing a New Line Source*, page 12-71.
4. Remounting line source compartment covers.
   See section 12.5.3.10, page 12-77.
5. Attaching the line source compartment to the AC option bracket.
   Reverse instructions given in section 12.5.1.2, page 12-33.

12.6.3.4 Mounting the Transmission Scanners

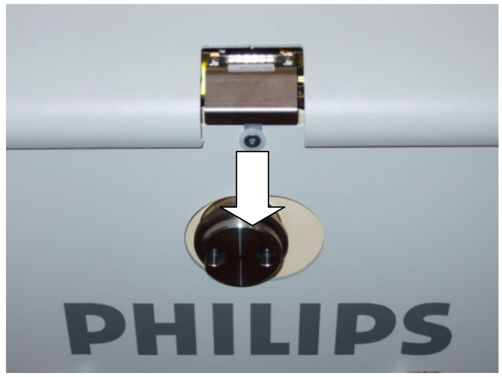
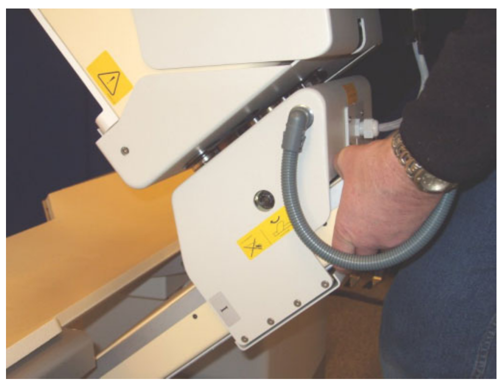
Before starting to mount the transmission scanners, the detector assembly must be positioned conveniently for accessing both detector ends.

Procedure	***Details***
Power up the gantry:	
1. Set the main switch at the back of the gantry base to the ON position.	
2. Press the hand controller Collision Override button to enable power to the motors.	
3. Use the hand controller to position the detector assembly conveniently for accessing the end of both detectors.	
A convenient position is approximately: Det ang.: – 45° Det Y: 1180 mm Det X: 0 mm.	
Power down the gantry:	
4. Set the main switch at the back of the gantry base to the OFF position.	



WARNING

Be careful when mounting the transmission scanner on the detector. The transmission scanner weighs more than 40 lbs.

Procedure	***Details***
5. Remove the collision circuit jumper from the DB15 connector on the detector end. Make sure to store the collision circuit jumper in a place from where it can easily be retrieved next time the transmission scanners need to be removed.	
The photos on the right show the guide pins on the detector and the mounting plate on one of the transmission scanners.	 
6. Position transmission scanner 1 on detector 1 by engaging the three guide pins on the detector 1 end piece into the cutouts in the steel mounting plate on the trans-mission scanner bracket.	
7. Push the handle into the locked position to mechanically lock the transmission scanner to the detector. **Note**. The label on the AC Option bracket indicates the locked and unlocked position of the AC Option handle.	 Handle in unlocked position  Handle in locked position

Procedure	*Details*
8. Connect the cable from the transmission scanner to the socket on the detector as shown in the photo on the right: Insert the cable plug into the socket. Tighten the screws to secure the connector. While the cable is connected, the handle cannot be moved to the unlocked position.	
9. Repeat steps 5 to 8 to mount and connect transmission scanner 2 on detector 2.	

12.6.4 Software Installation

12.6.4.1 Upgrading EDC Board Firmware

The CardioMD AC option requires EDC board firmware 7CTL0095-E05 or later. The system's current EDC board firmware revision is recorded in the system log file. Check the most recent log file in the directory `C:\cardiocam\SystemLog`.

Tools Required

- CardioMD™ installation Disk. P/N: 9CSY0906.

Procedure

Refer to Chapter 7 *Software Update Procedures*, the section *Upgrading EDC Firmware* for instructions.

12.6.4.2 Installing AC Option Acquisition Software

The CardioMD software is shipped on a CD-ROM that includes two batch files used to update or perform a complete reinstallation of the acquisition software. To install the AC Option software, perform an update of the acquisition software as described below.

Tools Required

- CardioMD™ installation Disk. P/N: 9CSY0906.

Note. As a precaution, before updating the CardioMD software, perform a back-up of all user data on the system, i.e. detector calibrations, user-defined protocols etc. See the Appendix of the CardioMD Operator's Manual for instructions.

Note. As a precaution, ensure that the previous software version CD-ROM is available in order to be able to restore the original version of the acquisition software.

Procedure

Procedure	*Details*
Power up the gantry and start the acquisition PC:	

10. Set the main switch at the back of the gantry base to the ON position.
11. Press the acquisition PC's power switch.

An acquisition PC running Microsoft Windows 2000 will prompt you to log on by pressing [Ctrl] + [Alt] + [Delete]:

12. Press the three keys simultaneously to log on the the PC.

    Enter the username: CardioMD. Note that the user name is case sensitive.

    Enter password: CardioMD. Note that the password is case sensitive.

When the acquisition PC has finished booting:

13. Insert the CardioMD software installation CD in the acquisition PC's CD-ROM drive.
14. Right-click the Windows Start button and select **Explore** from the pop-up menu.

This starts the Windows Explorer.

15. In the Folders list, select the CD-ROM drive.

The contents of the CD-ROM's root directory appear in the file list on the right.

16. Run the file `InstallCardioMDupdate.bat` by double-clicking on this filename in the Windows Explorer's file list.
17. Follow the instructions provided.
18. When the software installation is completed, remove the software CD-ROM and store it in a safe place along with the backup disks.
19. Proceed to configure the AC Option software as described in the following section.

12.6.4.3 Software Configuration of AC Option

Procedure	***Details***

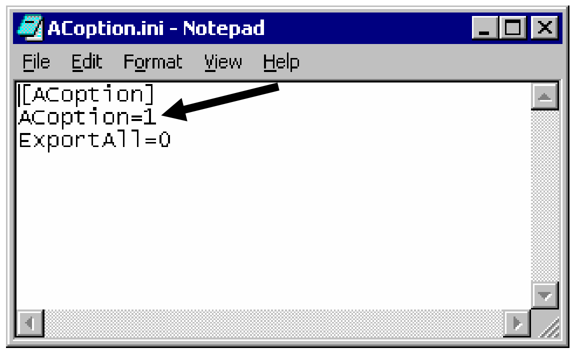
Start the Windows Notepad application:

1. Click the Windows Start button. Then select **Programs**, **Accessories** and **Notepad**.

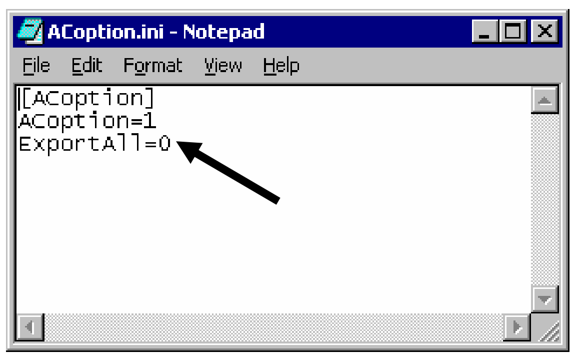
2. In the Notepad window, select **File**, **Open**.
3. In the Open dialog box, select **All files** from the Files of Type drop-down list.
4. Select the file: `C:\Cardiocam\ACoption.ini` and click Open.

The entry `ACoption=0` indicates that the AC option is disabled.

5. Change the line to say `ACoption=1`.



The entry `ExportAll=0` indicates that when the acquisition PC is set up to automatically transfer study files to the processing station immediately after a study is completed, only selected study files from AC SPECT and Gated SPECT studies are exported.



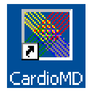
To set up the acquisition PC to export all AC study files automatically to the processing station:

6. Change the ExportAll entry to say `ExportAll=1`.

More detailed information on exporting AC study files can be found in Chapter 7 *CardioMD AC Option* of the CardioMD Operator's Manual.

When all corrections are done:

7. Select **File**, **Save** to save the modified `ACoption.ini` file.
8. Click the Close button to close down the Notepad program.

Procedure	*Details*
9. Double-click the CardioMD icon on the acquisition PC's desktop to restart the CardioMD application.	

12.6.5 Getting Ready to Use the CardioMD AC Option

Before the AC option is ready to be used, you must perform the following:

- Mechanically align the transmission scanners. See section 12.5.3.12, page 12-81 for instructions.
- Acquire a reference scan.
- Acquire a tomography with attenuation correction.

12.6.5.1 Acquiring a Reference Scan

1. Acquire a reference scan as explained in the CardioMD Operator's Manual Chapter 7 *CardioMD AC Option*.

When the reference scan is completed:

2. Check that the uniformity is less than 10 %.

12.6.5.2 Acquiring a Tomography with AC

1. Acquire a tomography with attenuation correction. See the CardioMD Operator's Manual Chapter 7 *CardioMD AC Option* for instructions.

When the tomography is completed, check the following:

2. Check that the count rate lies between 50 kcnts and 70 kcnts using LEHR collimators and a new line source with the line source attenuator in the closed position (see section 12.5.3.9, page 12-75).

   After approximately 1 year of using a line source, the count rate should lie between 50 kcnts and 70 kcnts using a LEHR collimator and the line source attenuator in the open position.

3. Check that no frames are missing and that all projections look uniform.

12.7 AC Option Spare Parts

12.7.1 Spare Parts Listing

12.7.1.1 AC Spare Parts in Gantry and Detector

12 NC part no.	*DDD part no.*	*Description*	*Qty per system*
DDD9ACP1316A	9ACP1316-A	Power interface board	1
DDD9CBL1313A	9CBL1313-A	Detector interface cable	1
DDD9CBL1314A	9CBL1314-A	CANbus interface cable	1
DDD9ACI1312A	9ACI1312-A	EDC AC interface board	2
DDD9POW1315A	9POW1315-A	AC PSU assembly	1
DDD9AES1317A	9AES1317-A	48V E-Stop board	1
DDD3PSU1689A	3PSU1689-A	120W AC-DC converter	1
DDD9CBL1450A	9CBL1450-A	PSU to main PSU 115 V cable	1
DDD9CBL1451A	9CBL1451-A	PSU to main PSU 24 V cable	1
DDD9CBL1452A	9CBL1452-A	48 V PSU cable set	1

12 NC part no.	*DDD part no.*	*Description*	*Qty per system*
DDD9CBL1482A	9CBL1482-A	55 V split cable	1

12.7.1.2 AC Spare Parts in Bracket

12 NC part no.	*DDD part no.*	*Description*	*Qty per system*
DDD9CBL1357A	9CBL1357-A	AC box cable	2
DDD9CBL1344A	9CBL1344-A	AC module cable	2
DDD9ACO1429A	9ACO1429-A	Motor and gear assembly	2
DDD9LIM1358A	9LIM1358-A	Set of limit switches (four pieces)	2
DDD9AMD1318A	9AMD1318-A	Motor power board	2

12.7.1.3 AC Spare Parts in Line Source Compartment

12 NC part no.	*DDD part no.*	*Description*	*Qty per system*
DDD9ACO1397	9ACO1397-A	Line source housing with line source*	2
DDD9EMC1411A	9EMC1411-A	Motion controller for transmission scanner 1	1
DDD9EMC1410A	9EMC1410-A	Motion controller for transmission scanner 2	1
DDD9MOT1359A	9MOT1359-A	AC servo motor	2
DDD9SOL1370A	9SOL1370-A	Solenoid	2
DDD9SMI1350A	9SMI1350-A	AC source motion board	2
DDD9CBL1369A	9CBL1369-A	MC interface cable	2
DDD9CBL1398A	9CBL1398-A	Collision sensor assembly (long + short)	2
DDD9LED1412A	9LED1412-A	Yellow LED indicator	2
DDD9COL1409A	9COL1409-A	Collision strip	2

* **Note**. Line source housing with line source must be ordered from:
Isotope Products Laboratories, Inc., 24937 Avenue Tibbitts Valencia, CA 91355.
Nuclear Medicine Sales: Phone: (800) 551 9767 Fax: (661) 257 8308.
Order No. NES8497

12.7.1.4 AC Option Accessories

12 NC part no.	*DDD part no.*	*Description*	*Qty per system*
DDD9ACO1422A	9ACO1422-A	AC option source holder	1
DDD9PLG1345A	9PLG1345-A	Dummy connector (collision circuit jumper)	2

12.7.2 Location of Spare Parts

12.7.2.1 AC Spare Parts in Gantry and Detector

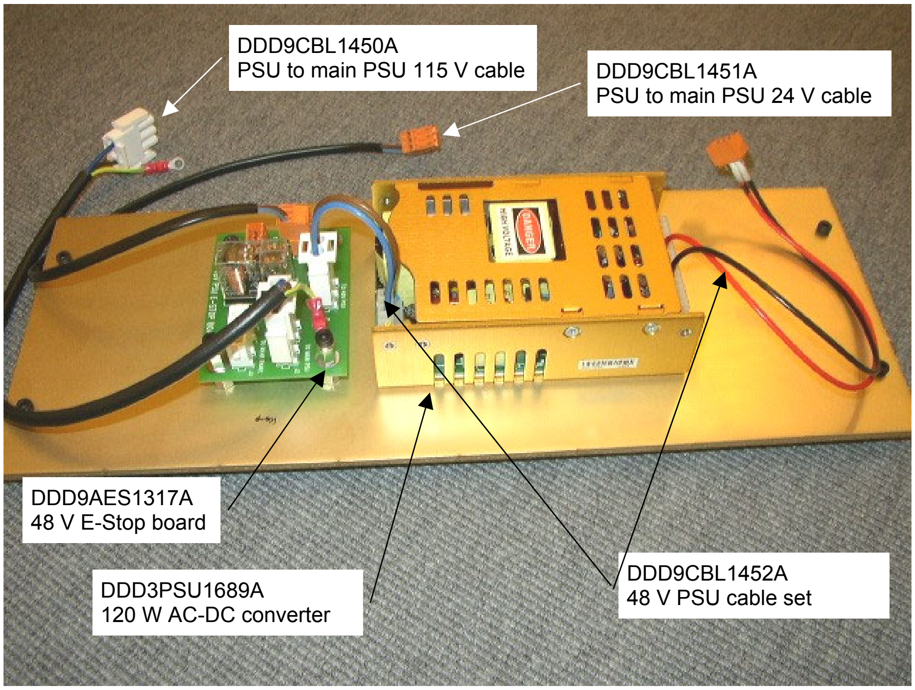


Figure 12.24 AC spare parts in gantry – DDD9POW1315A AC option power supply and component parts

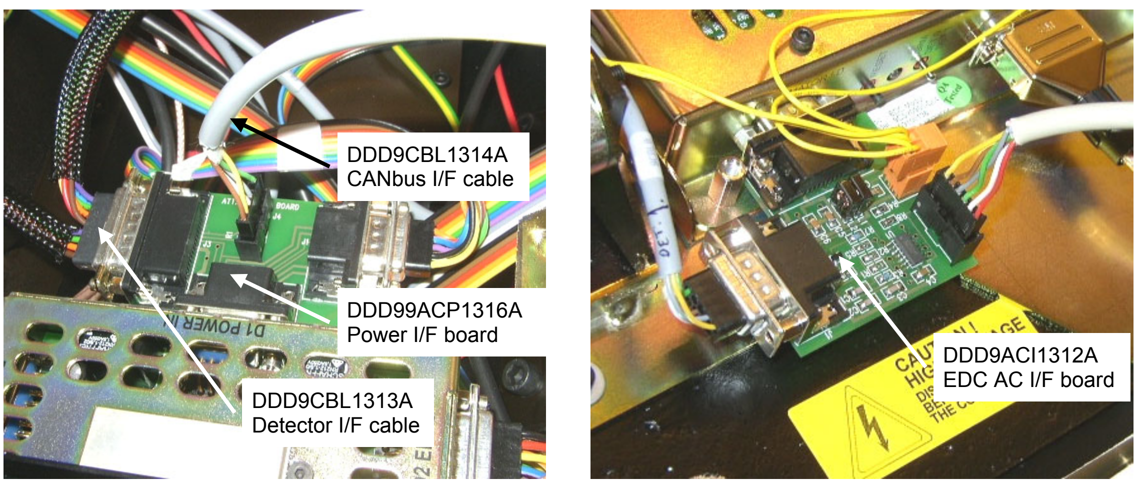


Figure 12.25 AC spare parts in detector

12.7.2.2 AC Spare Parts in Bracket

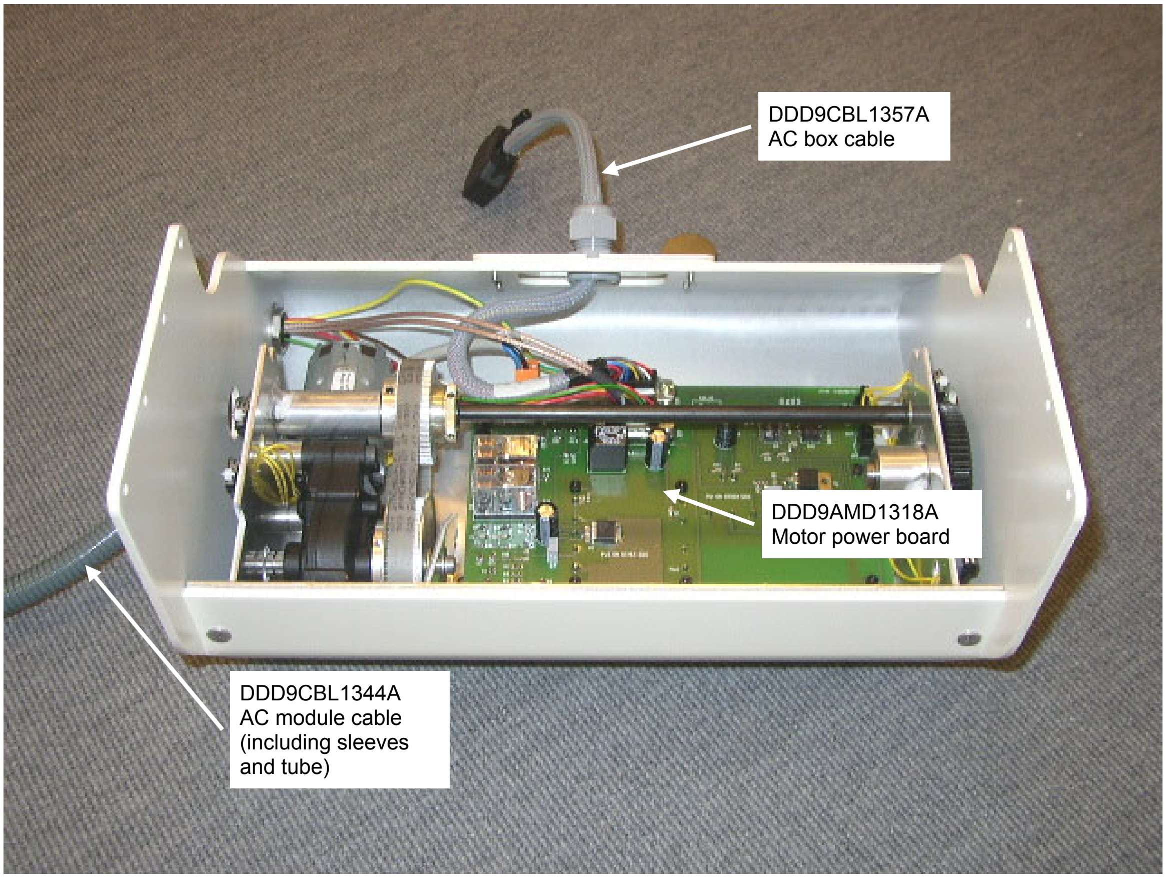


Figure 12.26 AC spare parts in AC option bracket

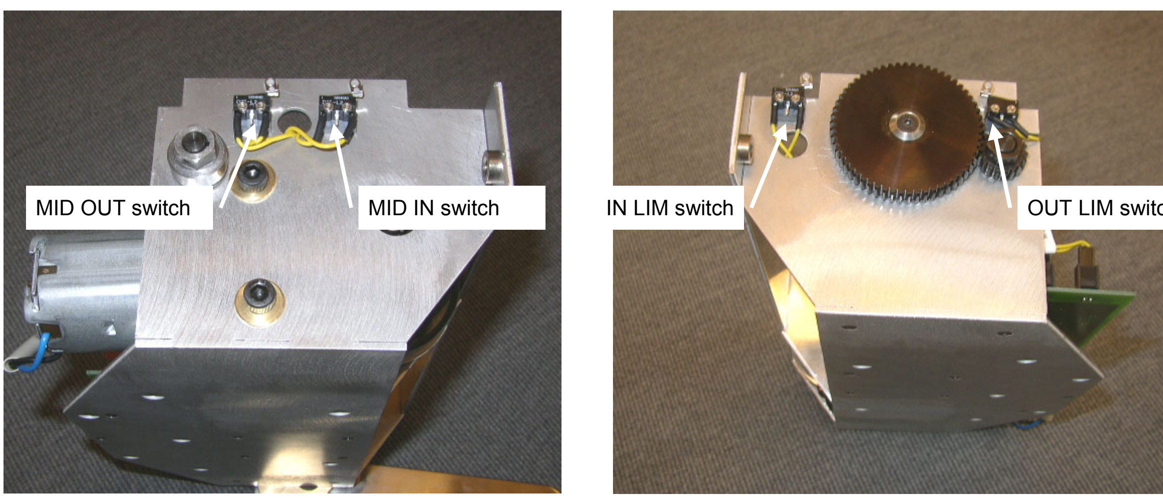


Figure 12.27 DDD9LIM1358A Set of limit switches

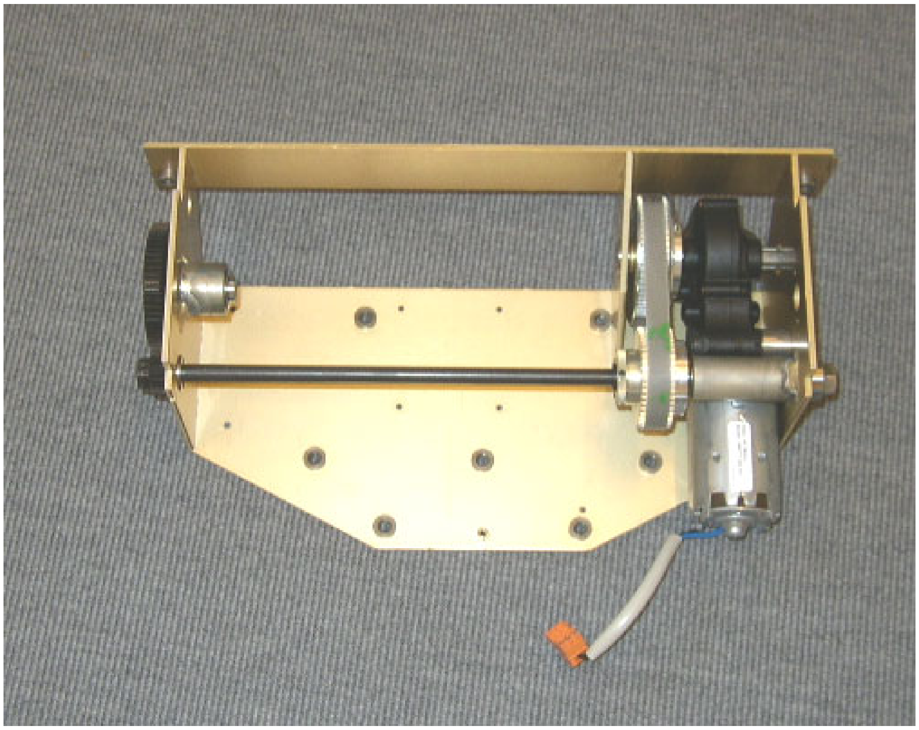


Figure 12.28 DDD9ACO1429A Motor and gear assembly

12.7.2.3 Spare Parts in Line Source Compartment

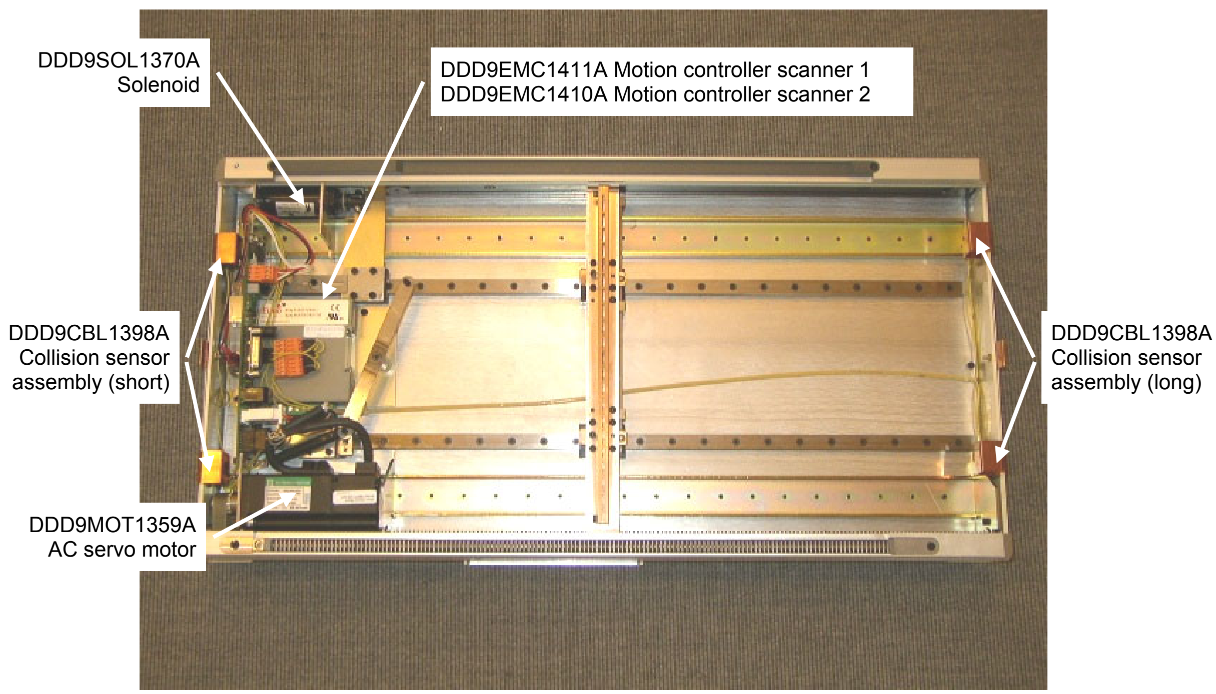


Figure 12.29 Spare parts in line source compartment

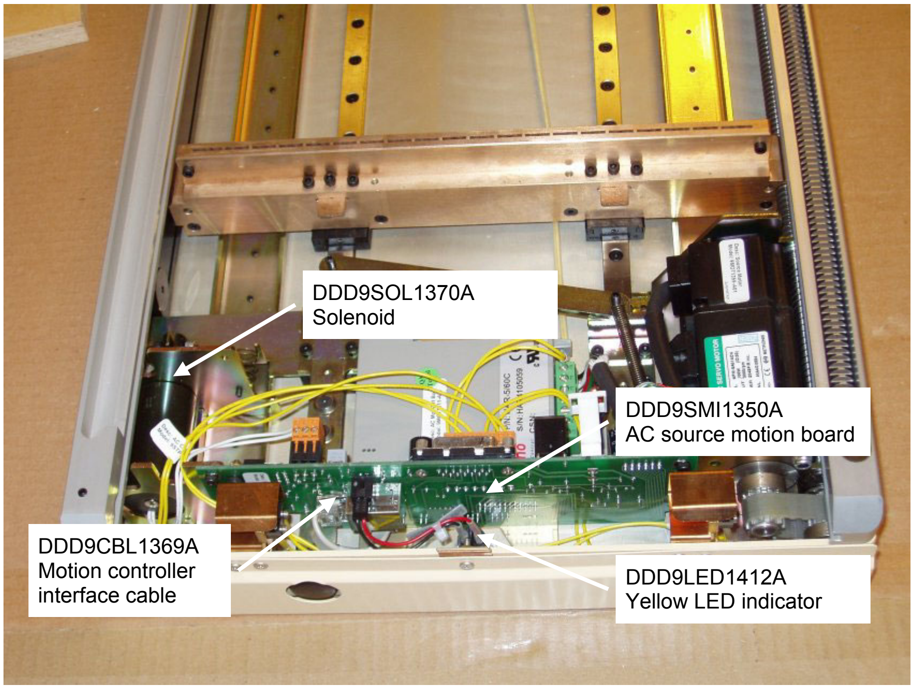


Figure 12.30 Spare parts in line source compartment (cont.)

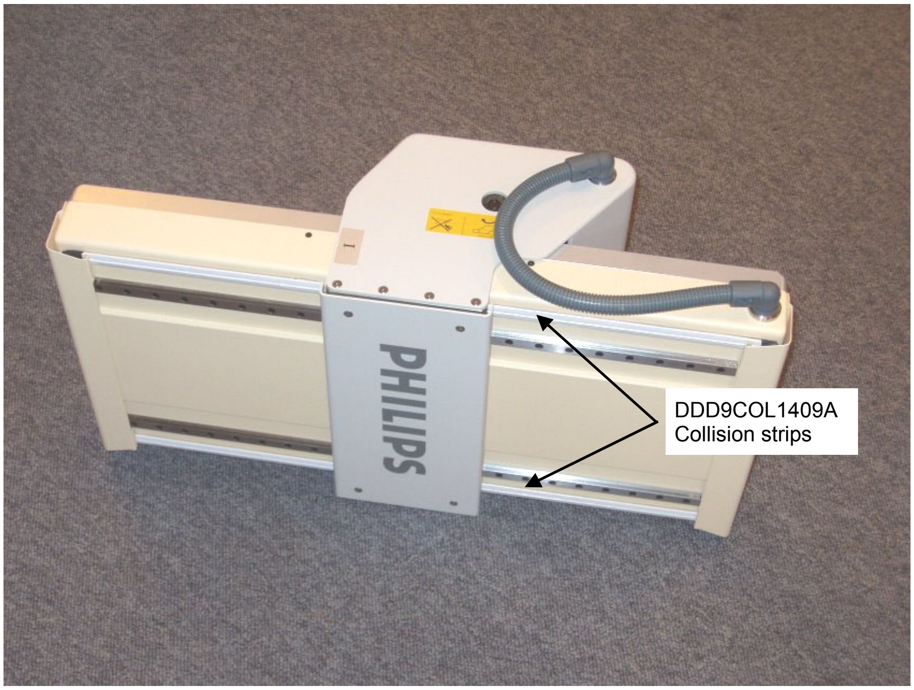


Figure 12.31 DDD9COL1409A Collision strips

12.7.3 AC Option Accessories

Figure 12.32 DDD9ACO1422A AC option source holder

12.8 Planned Maintenance

12.8.1 Lubrication

12.8.1.1 Tools required

- Grease: Klüber Microlube® GL261.

12.8.1.2 Acme Screw

The acme screw in the line source compartment must be greased every 6 months.

Procedure	*Details*
1. Use a brush to apply Microlube grease along the entire length of the Acme screw inside the line source compartment.	

0086

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